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Of Nature trusts the mind which builds for aye."*—WORDSWORTH.

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NATURE

A WEEKLY ILLUSTRATED JOURNAL OF SCIENCE.

"*To the solid ground
Of Nature trusts the mind which builds for aye.*"—WORDSWORTH.

THURSDAY, NOVEMBER 7, 1901.

THE HIND-BRAIN OF THE MONOTREME.

Die Medulla Oblongata und die Vierhügelgegend von Ornithorhynchus und Echidna. Von A. Koelliker. Pp. vi + 100. (Leipzig: Engelmann, 1901.) Price 16*s.*

DETAILED knowledge of the brain of the Monotreme has in recent years been considerably extended by the works of Profs. Elliot Smith, of Cairo, and Ziehen, of Jena. Material suitable for successful prosecution of microscopical research in this field is necessarily rare. It is a matter for congratulation that such material should have reached the hands of a veteran histologist, Prof. v. Kölliker. His monograph deals with the arrangement of nerve-fibre bundles and of nerve-cell groups in the mid-brain and hind-brain of ornithorhynchus and of echidna respectively. The study is based on transverse sections stained with hæmatoxylin by the Weigert method for nerve-fibres. The ornithorhynchus brain furnished for the regions studied a series of 1088 sections. Detailed drawings under defined enlargement are given for sections at eighteen of the levels. Among the points of interest ascertained the following appear the chief.

Both monotremes offer in common certain features in contradistinction to other mammalia. Noteworthy among these are the subjoined.

The fourth ventricle extends very far distally, so far, in fact, that instead of the anterior half of the cell-group of origin of the hypoglossal nerve, the whole length of that cell-group lies practically uncovered in the floor of the ventricle. The hypoglossal cell-group lies, not next the raphe and under the longitudinal bundle, but away at the side of the ventricle.

The root of the cochlear nerve enters the bulb by piercing it ventral to the peduncle of the cerebellum; none of its fibres wind round the peduncle. But the so-called striæ acusticæ exist nevertheless on the dorsal aspect of the bulb.

The facial nerve has, in addition to its regular nucleus, a second widely separate and dorsal to that, near below the genu of the nerve root. The sensory root of the trigeminus is very large, and enters the brain entirely anterior to the pons.

The pons is poor in cell-groups proper to itself. In echidna there are some cell-groups in its lateral portions as well as in the median, but in ornithorhynchus there are no lateral cell-groups at all.

The great system of fibres—the "fillet" or sensory system—ascending toward the brain and fed by secondary relays from the usual recipient afferent cell-groups is well developed, and exhibits the general arrangement obtaining in higher mammals. On the other hand, the system of fibres—the pyramidal—descending from the hemispheres to form connections with the efferent nuclei is so poorly developed that its very existence is not absolutely certain, at least for ornithorhynchus. It is of interest to note that the great efferent cerebral system can coexist in so meagre an extent in forms which possess an afferent spino-cerebral system so extensive. Thus as a permanent condition we have a state of things similar to that which regularly forms a transient stage in the development of the higher type of mammalian nervous system.

Among features of interest offered by the two brains individually, and therefore to be considered more or less apart each from the other, are the following:

In ornithorhynchus, with its small cochlear nerve, there is discoverable only a mere trace of any superior olive. In echidna, with its large cochlear nerve, the superior olive is a structure of considerable extent.

In echidna a large system of fibres passes along the lateral region of the bulb to the outer side of the sensory root of the trigeminus. These fibres in the upper pontine levels bend inward, decussate, and ascend again in the *pes pedunculi cerebri* of the crossed side. They are traceable at least as far as the optic thalamus. Kölliker urges that it is a sensory spino-cerebral system, but the merely anatomical method employed affords no trustworthy guide to the functional direction of the path.

The central nervous system of echidna represents, on the whole, a grade of development distinctly superior to that of ornithorhynchus. Traces of a pyramidal system fairly distinct though very scanty can in echidna be

followed into the proximal end of the spinal cord. In ornithorhynchus, Ziehen could not satisfy himself about the existence of any pyramidal system. Prof. Kölliker believes he can distinguish a pyramidal decussation in ornithorhynchus and that the fibres of it plunge mainly into the dorsal column of the spinal cord (as in the rat and guinea-pig) and not into the lateral column, as in the generality of mammals. But the description he gives is a very unsatisfactory one, and no mention is made of his data for discrimination between the undoubtedly existent fillet decussation and the equivocally existent pyramidal. Moreover, he admits that he finds in ornithorhynchus no trace of longitudinal fibres passing anywhere along the pons. In arguing for the existence of a pyramidal system, he omits mention of what to most minds forms the strongest argument yet adducible, namely, that, as shown by Prof. C. J. Martin, of Melbourne, excitation of a certain region of the cerebral cortex of ornithorhynchus evokes movement of the crossed fore-limb.

The large extent and specially sentient character of oral-facial surface in ornithorhynchus prepares the observer for a large recipient nucleus in the bulb to subserve the huge sensory root of the trigeminus. This root and its recipient nucleus form a huge projection either side the bulb—the tuberculum quinti, well shown in a figure reproduced from Elliot Smith. Prof. Kölliker finds fibres of this root traceable to the nuclei of the *hypoglossus*, *vago-glossopharyngeus* and *abducens*, as well as to that of the trigeminus itself. From the recipient nucleus of trigeminus he traces fibres to the median fillet, and so to the optic thalamus. C. S. S.

DIVERGENT SERIES.

Leçons sur les Séries Divergentes. Par Émile Borel. Pp. viii+184. (Paris: Gauthier-Villars, 1901.) Price fr. 4.50.

TO make the object of this work intelligible, it is necessary to recall a few facts concerning infinite series in general. Suppose we have a sequence

$$u_1, u_2, u_3, \ldots u_n, \ldots \qquad (U)$$

where u_1, u_2, &c., are analytical expressions constructed by a definite rule. Let $s_n = u_1 + u_2 + \ldots + u_n$; then we have a derived analytical sequence

$$s_1, s_2, s_3, \ldots s_n, \ldots; \qquad (S)$$

this is a definite analytical entity, and its properties are implicitly fixed by those of the former sequence. The expressions u_n, s_n are, of course, functions of n; we may suppose, for simplicity, that, besides this, they involve, in addition to definite numerical constants, a single analytical variable, x. If we assign to x a numerical value, S becomes an arithmetical sequence, and three principal cases arise, according to the behaviour of s_n when n increases indefinitely. If s_n converges to a definite limit s we say that this is the sum of the series $u_1+u_2+u_3+\ldots$, and write $s=\sum_1^\infty u_n$; but the ultimate value of s may be either indeterminate or infinite. In the second case Σu_n has no definite meaning; in the third we may say, if we like, that Σu_n is infinite, but this infinite sum is not a quantity with which we can operate, and presents no special interest.

When the series Σu_n and Σv_n are absolutely convergent we can add and multiply them according to the rules

$$\Sigma u_n + \Sigma v_n = \Sigma(u_n + v_n)$$
$$\Sigma u_n \times \Sigma v_n = u_1 v_1 + (u_1 v_2 + u_2 v_1) + (u_1 v_3 + u_2 v_2 + u_3 v_1) + \ldots$$
$$= \sum_n \sum_r (u_r v_{n+1-r}):$$

now the sequences

$$u_1+v_1,\ u_2+v_2,\ \ldots\ u_n+v_n,\ \ldots \qquad (A)$$
$$u_1v_1,\ u_1v_2+u_2v_1,\ \ldots\ u_1v_n+u_2v_{n-1}+\ldots+u_nv_1,\ \ldots \qquad (B)$$

can be constructed, whether or not the sequences $(u_1, u_2, \ldots)$ and $(v_1, v_2, \ldots)$ are convergent; the question therefore arises whether it is possible, even when the series Σu_n, Σv_n are divergent, to associate with the sequences $(u_1, u_2 \ldots)$ and $(v_1, v_2, \ldots)$ certain finite and determinate functions U, V in such a way that U+V and UV may be *by the same rule of correspondence* associated with the sequences (A) and (B) above.

Among the various ways in which this can be done, M. Borel's method of exponential summation is particularly interesting. Briefly it is this: let

$$u(a) = u_0 + u_1 a + \frac{u_2 a^2}{2!} + \frac{u_3 a^3}{3!} + \ldots + \frac{u_n a^n}{n!} + \ldots$$

then the function

$$s = \int_0^\infty e^{-a} u(a)\, da$$

is defined to be the *exponential sum* of the series $u_0+u_1+u_2+\ldots$. When Σu_n is convergent, s coincides with the sum in the ordinary sense; the important point is that s may be finite even when Σu_n is divergent; the series is then "exponentially summable"—*absolutely* so, if

$$\bar{s} = \int_0^\infty e^{-a} \mid u(a) \mid da$$

is a convergent integral. M. Borel proves that (in the case of absolute summability) if U, V are the exponential sums of Σu_n and Σv_n, then U+V and UV are the exponential sums of the series whose terms are given under (A) and (B) above; in other words, the formal laws of rational operation are satisfied. In a similar sense, an absolutely summable series may be differentiated any number of times.

As an example of the practical value of these results, suppose we have a differential equation $F(y, y', y'', \ldots)=0$ in which $y, y', y'' \ldots$ enter rationally: then, if this is found to be formally satisfied by a series Σu_n, which, although divergent in the ordinary sense, is exponentially summable, the exponential sum is actually a solution of the differential equation.

In Chapter iv. M. Borel applies the idea of exponential summation to an interesting problem in function-theory. Suppose we have a power-series

$$u_0 + u_1 x + u_2 x^2 + \ldots$$

which is convergent within a circle of finite radius, but divergent outside of it. Within the circle, this series defines a function of x, say $f(x)$; within the same region the series is exponentially summable, and its sum is $f(x)$. But the exponential sum may exist and be finite in a region *larger* than the circle of convergence of the power-series; in this case the exponential sum is an analytical continuation of $f(x)$ outside the circle, and the new region

of summability is shown to comprise an area bounded by a (finite or infinite) number of straight lines, each of which goes through a critical point. This new region M. Borel calls the *polygon of summability*. An obvious question arises here; does the continuation of $f(x)$ obtained by exponential summation necessarily coincide with one obtained by other methods, for example Weierstrass's? In some cases it certainly does; for instance, when $f(x)$ is a rational function of x, or one branch of an algebraic function.

So far it has been supposed that the object of inquiry is in the first instance a series given by the law of construction of its terms; and the main result has been to show how, in certain cases where the series is divergent in the ordinary sense, it may be associated with a finite function, called its sum (in an extended sense), which the series so far represents that relations satisfied formally by the series are actually and arithmetically satisfied by its sum. But there is another side of the question which is of equal importance, especially from the practical point of view. We may have a function explicitly or implicitly defined by certain properties, and try to obtain a series which for purposes of computation or otherwise may be regarded as its equivalent. A typical illustration is afforded by the ordinary process of solving differential equations by series; here we have a uniform method which, if it does not fail altogether, leads us to a power-series, formally satisfying the equation, but not necessarily convergent. Exponential summation, when it is applicable, enables us to obtain a solution from the merely formal equivalent. In this connection we have Poincaré's theory of asymptotic series, which is expounded by M. Borel in Chapter i. Independently of its convergence, the expansion

$$c_0 + \frac{c_1}{x} + \frac{c_2}{x^2} + \ldots + \frac{c_n}{x^n} + \ldots$$

is said to represent $f(x)$ asymptotically if

$$x^n \left[f(x) - c_0 - \frac{c_1}{x} - \frac{c_2}{x^2} - \ldots - \frac{c_n}{x^n} \right]$$

vanishes when x is infinite. Asymptotic expansions may be combined by the ordinary formal rules of rational operations, and the result is asymptotically equivalent to the corresponding combination of the functions represented. These considerations justify the use of semi-convergent series in computation; the classical example occurs in the theory of the gamma function. It must be carefully observed, however, that although the asymptotic expansion (if it exist) of a definite function is itself definite, we *cannot* infer the existence of a definite function corresponding to a given expansion $\Sigma c_n x^{-n}$: the reason of this rather paradoxical result is that innumerable functions (for instance e^{-x}) lead to an asymptotic expansion with zero coefficients throughout.

In Chapter ii. M. Borel discusses the results contained in Stieltjes's memoir (*Annales de la Faculté des Sciences de Toulouse*, tt. viii. ix.), and in Chapter v. deals with the polynomial expansions due to Mittag-Leffler. Interesting as they are, it seems hopeless to try to analyse these chapters within the compass of a review; they are, indeed, themselves of the nature of summaries, and will be best appreciated by those readers who accept M. Borel's invitation to consult the original memoirs. Attention may, however, be called to the author's estimation of these researches. It is, in effect, that the memoir of Stieltjes, though of great originality and suggestiveness, is of restricted application and not likely to lead to a general theory; and that, on the other hand, while Mittag-Leffler's theory does not immediately afford a calculus of divergent series, in the proper sense of the term, it may very probably lead to one. It should be added that M. Borel himself has made substantial contributions to this theory of polynomial expansions; some of them appear for the first time in the present volume.

The fact is that most of the field traversed in this very attractive course is of recent discovery, and we cannot expect to be presented with a complete and symmetrical doctrine all at once. Let us be thankful that M. Borel, himself one of the pioneers on this novel route, has so clearly and impartially indicated the progress that has hitherto been made.

G. B. M.

OUR BOOK SHELF.

The Chemical Essays of Charles-William Scheele. Pp. xxx + 294. (London: Scott, Greenwood and Co., 1901.) Price 5*s*. net.

THIS is a reprint of Dr. Beddoes' translation of Scheele's essays, which was published in 1786 by John Murray and may still be picked up occasionally in second-hand book shops. The reproduction is faithful even to the mis-spelling of Priestley's name in Beddoes' preface. Between this preface and the essays, however, there now appears a memoir of the life and work of Scheele, written for the reissue by Mr. John Geddes McIntosh. Mr. McIntosh presumably has inspired the reissue of the essays, and if this will be the means of getting them more generally read by students of chemistry, he may so far prove a benefactor.

Of the essays themselves it is hardly necessary to say anything. The facts they establish belong for the most part to what is now very elementary chemistry and the phlogistic hypothesis with which the explanations are involved did not long outlive Scheele; but the spirit which breathes in these essays and the method they inculcate can never grow commonplace or antiquated.

The strict fidelity to experiment, the rare sagacity, the scrupulous and minute observation and the extraordinary experimental skill combine to make Scheele a model for all time. When we add to this the pathos of his early struggles, the simplicity of his blameless life and the nobility of his untimely death, there can be no wonder that Scheele is reckoned a hero among chemists.

It cannot be said that the memoir which accompanies these essays is worthy of the subject. Mr. McIntosh has apparently considerable enthusiasm for the solid virtues of Scheele and for the material outcome of Scheele's discoveries, but he shows little critical insight or literary taste. Speaking, for example, of the discovery of chlorine, he says: "Let us now glance at the radical errors of the French school, the chief of whom was Berthollet, the man who was the first to make practical application of Scheele's discovery, and, as is usually the case with such men, they propound a theory of their own, so that some at least of the merit, if not all of the original discovery, may descend upon their own mantle."

The violence here done to Berthollet, to the rules of English composition, and to a time-honoured metaphor is very remarkable.

On the following page it is stated to be "a well-known fact at the present day" that the product of distilling fluorspar and sulphuric acid in a glass retort is gaseous hydrofluosilicic acid.

The essay concludes with a comparison of Scheele with Shakespeare, somewhat to the disparagement of the poet, and with a very comical lament that so few people ever visit either Scheele's birthplace, "if it still be in existence," or his shrine at Köping, "where he died and where presumably his remains are interred." One might even suspect that Mr. McIntosh had not been there. A. S.

Use-Inheritance; Illustrated by the Direction of Hair on the Bodies of Animals. By W. Kidd. 8vo. pp. 47. Illustrated. (London: A. and C. Black, 1901.) Price 2s. 6d. net.

EVERY naturalist who has studied the ungulate mammals must have been struck with the curious variation in the direction of the hair which occurs even in closely-allied species, and has probably been much puzzled to account for these differences. Why, for instance, do the hairs on the back of all the Asiatic buffaloes point towards the head and those of their African allies in the opposite direction? In the former animals, as in all analogous instances, a whorl (in this case on the haunches) marks the point where the change in the direction of the hairs from the normal backward slope occurs. In the work before us the author, although he has not attempted to give a reason for the variation in the hair-slope of closely allied species, has done good service by classifying these "whorls" and "featherings," as typified in the horse. He has also shown that these features always occur at spots where two or more muscles are acting against one another, as is well exemplified on the forehead of the horse. It is therefore suggested that the production of such whorls has a dynamical origin. It is noteworthy that while whorls and featherings are very commonly developed in short-haired mammals, they are either absent or rudimentary in those with long hair.

The main argument of the book is, however, connected with certain peculiarities of the hair-slope in man. In normal instances this slope on the back of the head and neck diverges obliquely from the middle line, somewhat after the simian fashion. But in a second, or "exceptional," type the direction is just the reverse of this. It is suggested that while the normal type has been directly inherited from simian ancestors, the exceptional type (which is considered to be an acquired one) has been derived from the female line. It is further shown than on the human back the direction of the hair-slope is quite different from that which obtains in all apes and monkeys. "This aberration of hair-slope I have suggested," writes Dr. Kidd, "to be produced by the habit which man has of spending about a third of his life, during sleep, in lying mostly on his side, and, for some millenniums at least, with some sort of rest for his head."

These peculiarities in the hair-slope of man and other animals, adds the author, are congenital and not due to selection; hence, unless originally created with the forms of life in which they occur, they must have been produced in their ancestors by use or habit. From this it follows that, if the creation hypothesis be discarded, in this particular instance, at any rate, acquired characters are inherited.

While claiming recognition for his own views on this point, Dr. Kidd (p. 8) deprecates the idea that they militate seriously against the merits of Weismann's theory as a whole. It may be added that the language in which this tribute to a great thinker is couched would have been more elegant had the author avoided the triple use of the word "which" in a single sentence. R. L.

Foundations of Botany. By Joseph Y. Bergen, A.M. Pp. x + 257. (Boston, U.S.A.: Ginn and Co., 1901.)

THIS book is intended, or at least so we gather from the preface, to provide a year's work in an advanced school class. Much of the matter is to be commended, and some of the new figures are admirable. From this side the Atlantic one can only regard with envy the amount of energy expendable in American schools if a work of this proportion and scope is really suited to their possible requirements; for the book covers a wide range of subjects, and will make no small demands on the time of the student who aims at mastering its contents. The author clearly intends that the work shall be grappled with thoroughly, and from the concrete and practical side. He gives directions for laboratory work, and suggests problems to be solved by observation and experiment. These are incorporated in the text as appendices to the chapters, after the prevailing fashion in modern American text-books. It may, perhaps, be questioned whether the book might not be improved by the separation of the purely systematic portion into a volume by itself.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

The Exploration of the Atmosphere over the Ocean.

THE experiment of flying kites in calm weather from the deck of a moving tug-boat, which was mentioned in NATURE of September 5 (p. 453), was continued by my assistant, Mr. Sweetland, and myself on a steamship that performed the voyage from Boston to Liverpool between August 28 and September 5. Flights were made on five days, the greatest height reached by the meteorograph being one-third of a mile, and the records of barometric pressure, air-temperature, relative humidity and wind-velocity, which are probably the first to be obtained above the North Atlantic, were shown to Section E of the British Association at Glasgow.

These experiments demonstrate conclusively that, with a steamer that can be manœuvred at will, kites can be flown at sea in almost all weather conditions, and, consequently, a most important field is opened for their use in meteorological researches, especially in the tropics, where the conditions existing above the trade-winds are imperfectly known. It is to be hoped, therefore, that such an investigation will be undertaken either by the Government or by private enterprise, and I am now endeavouring to bring this about. A. LAWRENCE ROTCH.

Blue Hill Observatory, Hyde Park, Mass.,
U.S.A., October 25.

A Curious Flame.

THE kind of phenomenon described by Mr. Garbutt (p. 649) is frequently to be met with in "washed-out" flames, that is, in flames which are diluted to the point of extinction. In such cases the velocity of inflammation is so low that flame cannot propagate itself against the stream of gas. If the current of gas be baffled by an obstacle, then a flame may originate in the "slack waters" round the obstacle. No doubt the temperature of the obstacle is of some importance if the object be small, since rapid withdrawal of heat at any point of a gaseous current is a hindrance to the development of flame at that point. But it will be found that in the experiment described by Mr. Garbutt a flame may be obtained by opposing a large baffling surface of even an enduringly cold body such as a 56-pound weight. In this case a very large portion of the gaseous mixture is made stationary and the cooling down does not affect more than a small film next the metal. A kindred phenomenon is described in NATURE (vol. xlix. p. 86).

The flame obtained when a Bunsen lamp is lighted both at the bottom and the top of the tube is very feeble, and large tracts of it may be extinguished by holding in it beads of volatile salts. ARTHUR SMITHELLS.

November 4.

WITH regard to the flame described by Mr. Garbutt in your issue of October 31, I would suggest the following explanation, which, however, I have not as yet quite proved.

The products of the partial combustion at the bottom of the

Bunsen tube will, in this case, burn with the aid of external heat; but not without some such assistance, because the heat of combustion is so much absorbed by the diluting gases that the temperature of ignition would not otherwise be maintained.

The experiment reminds one of the burning of ammonia, and of a coal-gas flame rendered non-luminous by the admission of steam.

A consideration of Prof. Smithells' method of cone separation by a glass rod (*vide* NATURE, November 1892) might lead to the suspicion that the obstruction of the rod played some part in the phenomenon, but the above explanation is supported by the fact that the copper wire which, when cold, extinguishes a candle flame, does not, when warm, do so.

HERBERT KING.

The School, Wolverhampton, November 2.

The Colours of Guillemots' Eggs.

I AM glad to see that my friend Captain Barrett-Hamilton has written on the above subject, though it seems inconceivable to him that "the beautiful varieties of colouring must help each bird to distinguish her egg from others lying near until they all become stained and soiled." The quotation is from "The Birds of Ireland" (p. 364), in which I put forward, as an opinion, the conclusion that I have been led to after many a day spent in climbing among breeding guillemots.

Discussion of such opinions is to be welcomed, but they must be tested by close observation of the birds and their ways; and the guillemot finding its own egg among many is not the same thing as an animal finding its young, which has voice, smell, movement and expression, nor has the guillemot a nest to find.

It is asked, "Why should each guillemot be provided with a conspicuous private egg-pattern when other sea-birds, her neighbours, have to find their homes without such aid?"

Well, let anyone look down on a guillemot-ledge the last week in May, before the birds have begun to sit close, and he will be struck by the fact that each is provided with a conspicuous egg-pattern, the green eggs contrasting with the white ones and those heavily blotched with the streaked ones; and this is most obvious, even at some distance. I know no other eggs that show such vivid contrasts.

Does this contrast supply any want that the guillemot may have above other birds to enable it to find its egg? Her neighbours, my friend remarks, find their homes without such aid. But then each has her "home." The gulls and cormorants have their nests. Each puffin has its burrow. The razorbills lay much more in separate nooks than guillemots, but still they approach nearest to them both in the nature of their breeding places and in the varieties of egg-colouring. But guillemots lay and sit in packs, often touching one another, on open surfaces of rock (see the plate, "Birds of Ireland," facing p. 362). At first the eggs are often left uncovered and other guillemots alight, lay beside them, and they roll more or less. Must not the special colouring greatly enable the parent bird to find her egg while this is going on? Why should we deny her intelligence in a matter that concerns her, even though other birds are satisfied if they know the way to their nests and do not seem to distinguish whether the eggs in them are their own or not. Thus the cuckoo's egg is unquestioningly accepted by the foster-mother.

It is objected that my suggestion about the colour helping guillemots to distinguish their eggs is disproved by the subsequent admission that they all become stained and soiled as incubation advances; but at that stage each bird clings to her treasure and never leaves it, unless her mate relieves her (a point which needs proof).

The colouring of the eggs of this species is not protective, for it makes them gaudy. It is peculiar, and why should it not be useful during laying-time considering the very peculiar conditions under which guillemots breed? They sometimes come down with a thump among others which are hatching, they sometimes fight, they are awkward on their feet; eggs are not only moved, but many are thrown down, broken or lost in pools.

I wish some ornithologist would contrast from observation the guillemots' colonies on surfaces of rock with those of other birds that breed in packs without nests. Penguins appear to lay on earth and leave lanes between the nesting-places on which the birds travel on foot. That being so, their eggs would not be in such danger of being rolled about.

Cappagh, co. Waterford. R. J. USSHER.

THE TERCENTENARY OF TYCHO BRAHE'S DEATH.[1]

ON October 24, 300 years had elapsed since Tycho Brahe died at Prague, expressing in his last moments the hope that he might not appear to have lived in vain. When saying this he doubtless did not fear that the work he had accomplished might not turn out to be of permanent value, but merely regretted that the great goal he had looked forward to from his early youth, the complete reformation of astronomy, had not yet been fully reached. Could he have foreseen how brilliantly Kepler, who stood at his deathbed, was to complete the work, Tycho would have had no fear as to the lasting nature of his reputation.

It is difficult nowadays to realise that only a little more than 300 years ago it was not a self-evident proposition that the science of astronomy could only be firmly established by observing the heavens systematically year after year, and not merely by taking an odd observation now and then. And yet this does not appear to have occurred to anybody before Tycho, as even Copernicus records very few observations taken during his long life, so that the values of most astronomical quantities had still to be borrowed from Ptolemy. But in August 1563 the young Danish noble, then a student at the University of Leipzig, only sixteen years of age, commenced the series of observations which he carried on, with few interruptions, till the end of his life, thirty-eight years later. The instruments he used at first were crude enough, but already at that time the future reformer of practical astronomy was aware that a very inferior instrument may produce good work if all sources of possible errors are investigated and corresponding corrections are applied to the results of the observations. It is also worth noticing that the planets almost from the beginning claimed his undivided attention, so that the youthful observer had perceived that the existing planetary tables could only be improved if the computed places of the planets were systematically compared with observed places and the errors of the tables thus brought to light. Thanks to the great liberality of King Frederic II. of Denmark, Tycho was afterwards able for more than twenty years, with a multitude of instruments of improved construction and assisted by a number of pupils, to follow the motions of the sun, moon and planets, while he at the same time, by his observations of a thousand fixed stars, gave to the world a catalogue of accurate positions of these bodies which took the place of the old catalogue of Ptolemy and held its own for more than a hundred years, until the use of telescopes and clocks of precision enabled Flamsteed to produce much better star places.

That Kepler made use of Tycho Brahe's observations to find the laws which govern the planetary motions and thereby to free the Copernican system from the excentric circles and epicycles which it had taken over from the Ptolemean system is too well known to require repetition here. But Tycho did a great deal more than merely amassing materials for his successor. Not only was he the first observer who did not assume his instruments to be faultless but who studied their errors of construction, but he was also the first to investigate refraction and to attempt to correct his observations for it, and he succeeded in improving his instruments so much that it is difficult to see how a much greater accuracy could have been attained by succeeding generations, if the telescope had not been invented a few years after his death and if the application of the pendulum to clocks had not simplified many methods of observing. And Tycho was able to deduce many important results from his own observations. By showing that the comets

[1] "Tychonis Brahe Dani die xxiv Octobris A.D. MDCI defuncti operum primitias De Nova Stella summi civis memor denuo edidit Regia Societas Scientiarum Danica. Hauniæ, die xxiv Octobris A.D. MDCCCCI." Pp. 16 + 54 ff. + pp. 30; 2 plates.

observed by him had at most a very small parallax he proved that they were celestial bodies and not mere phenomena in the earth's atmosphere. Important as this discovery was, it is quite eclipsed by the splendour of Tycho's discoveries with regard to the motion of the moon. The ancients knew that the moon's orbit forms an angle of about 5° with the ecliptic, that the two points of intersection (the nodes) travel round the ecliptic in the direction from east to west in about nineteen years, also hat the earth is not at the centre of the lunar orbit, and hat the line of apsides completes a revolution (from west to east) in less than nine years. The great perturbation in longitude now known as the evection, by which the place of the moon may be put forward or backward as much as 1° 16′, was also known, having been dimly perceived by Hipparchus and clearly demonstrated by Ptolemy. But since his time no advance had been made (Sédillot's assertion that Abul Wefa discovered the variation has been clearly and finally disproved). The accurate and long-continued observations of Tycho Brahe revealed the existence of another inequality in longitude, known as the variation, which affects the place of the moon to the extent of 40′, by which amount the moon is ahead of her mean place about three and a half days after new and full moon, and as much behind it about three and a half days after the first and last quarters. He also found the annual equation or the lengthening of the moon's period of revolution in winter and its shortening in summer. Finally, Tycho discovered the variation of the inclination of the lunar orbit and the irregularity of the motion of the nodes. After this series of brilliant successes he cannot have doubted that his observations were destined to reveal the mysteries of planetary motion, and already in 1591 he had commenced to suspect the existence of unknown complications in the motion of Mars, which he afterwards alluded to in a letter to Kepler in 1598, in which he stated that the epicycle of Mars appeared to vary in size. Preparations had already been made for commencing the discussion of the observations of the planets, when an early death closed the life-work of Tycho and obliged him to leave the completion of it to Kepler.

The 300th anniversary of Tycho Brahe's death has been celebrated in his native land by a festive meeting of the Academy of Science at which the venerable King Christian was present, and at which orations were delivered setting forth the importance of Tycho's scientific work. At Prague, where he died, the monument over his recently restored tomb in the Teyn Church was again unveiled, and the interest which the citizens of Prague have always shown in the illustrious exile was manifested in various ways. But though Tycho towards the end of his life felt himself neglected in Denmark and left the country in order to enjoy the society of learned and congenial minds elsewhere, he never forgot the land of his ancestors and his birth; and on the titles of his last writings, as on his first, he describes himself as "Tycho Brahe Danus."

The Copenhagen Academy has chosen a very fitting way of doing honour to the memory of the greatest scientific man Denmark has produced by publishing a facsimile reprint of his earliest publication, "De nova stella" (1573). Tycho's four principal works are found in all great libraries and are not unfrequently met with in the lists of second-hand booksellers. But the book on the splendid new star which appeared in Cassiopeia in November 1572 is so extremely scarce that not a single historian of astronomy had ever seen it or even been able to give the title correctly until the writer of these lines gave an account of it in 1890. Tycho says himself that not many copies were printed and only a few were sent abroad, for which reason he afterwards reprinted the more important parts of it in his larger work, "Astronomiæ Instauratæ Progymnasmata," on which he was engaged during the last fourteen years of his life and which was published after his death. But the whole of the original book, as it left the hand of the young author, is of great historical interest, and we are glad to see the fine reprint now issued, as the star of 1572 was so intimately connected with the progress of Tycho's work.

In a short Latin preface and a Danish postscript of thirty pages, M. Pechüle, of the Copenhagen Observatory, has given a short summary of the origin and contents of the book. Tycho's manuscript was an astronomical, astrological and meteorological almanac for the year 1573, in which he, after a lengthy introduction (to the almanac proper), had inserted his essay on the new star, another on the lunar eclipse of December 1573 and a poem to Urania. After a good deal of persuasion by several friends, Tycho allowed the book to be printed in the spring of 1573, omitting, however, the main part of the almanac. It contains 53 ff, and has now been exactly reproduced in facsimile, but it has been collated with a MS. copy partly written in Tycho's own hand and preserved in the Imperial library at Vienna, in which way a few corrigenda were noticed which are given at the end of the reprint. The book, which is beautifully got up, also contains a specimen of Tycho's handwriting and a copy of a very fine portrait, drawn with pen and ink, found in the Royal collection of engravings at Copenhagen and by some ascribed to the Dutch engraver Goltzius, by others to the painter Gemperlin of Augsburg, who came to Denmark with Tycho in 1575 and afterwards painted the well-known portrait on his mural quadrant. To anyone acquainted with the contemporary literature on the new star and on comets this book will be of great interest, as it gives a very sober account of the startling celestial phenomenon which had given rise to a host of more or less worthless pamphlets and books, and shows that the want of parallax and motion proves the star to belong to the region of the fixed stars. At the same time, it is interesting to see that the author, who was destined afterwards to give the death-blow to the Aristotelean idea of the atmospheric origin of comets, was still a believer in this doctrine when he wrote his first book, but also that he was already then thoroughly aware that the great desideratum of astronomy was an extensive series of observations which he hoped to be able to supply if health permitted and the necessary means were granted him.

Scania, the province east of the Sound, where Tycho was born, and the little island of Hveen, on which his observatory stood, formed parts of the kingdom of Denmark from before the dawn of history and till 1658, when they were torn from the country which had not sufficiently valued him and incorporated in Sweden. It is therefore natural that the recent anniversary of his death also attracted attention in Sweden, and in honour of the day the Physiographic Society of Lund has published a *Festskrift* (20 pp., 4to., with three plates), in which Prof. Charlier, of Lund, gives an account of the recent exploration of the scanty remains of Tycho's buildings on the island. The foundations of Uraniburg were laid bare, as also the floors of the half-subterranean observatory (Stellæburgum (Stjerneborg), but scarcely anything was found more than what the clergyman Ekdahl unearthed in 1823. It has repeatedly, in 1823, in 1868 after the examination of the site by d'Arrest, and now again on the present occasion, been pointed out that "something ought to be done" to protect the ruins from wind and weather, and we may add from relic-hunters also. If this was desirable formerly, when Hveen was a lonely place to which nobody ever went, it has become infinitely more important now, as the island seems to have become the common resort of Sunday trippers from both shores of the Sound, and it would certainly be safer to cover up the foundations again than to leave them unprotected. It has recently been suggested that the observatory might easily be rebuilt from Tycho's detailed and

illustrated description and on the existing foundations and floors of the crypts, and no doubt this would be quite possible. But we confess we should prefer to see a large shed erected over the few stones that are left so that these venerable ruins could remain undisturbed. Most people would prefer looking at the ruins of Kenilworth Castle to walking through a sham castle erected on them and absorbing them. J. L. E. DREYER.

CELEBRATION AT PRAGUE.

Representatives of Bohemian science have recently shown that they delight to remember that Tycho Brahe, the great pioneer of modern observational astronomy, spent the last two years of his scientific activity in the capital of the Bohemian kingdom at a time when, as a seat of the Imperial Court of Rudolph II., the city was one of the most prominent centres of western European culture. It was at Prague that Tycho (Danish, Tyge) Brahe died on October 24, 1601.

The municipal council of Prague took part in the recent celebration, which excited much interest and received a large share of attention in the daily Press.

We cannot give here a detailed account of the scientific career of the great astronomer, but an outline will be of interest. Frederic II. of Denmark gave Tycho means for building the splendid observatory of Uraniburg, but after the death of his royal supporter Tycho was obliged to leave Denmark and his observatory, together with its valuable astronomical instruments.

Tycho went to his friend Count Rantzau at Wandsbeck in 1597 and two years later to the Court of the Emperor Rudolph II. at Prague. But the life at this Court was much too distracting for a scientific worker like Tycho, so he removed to the Imperial castle of New Benatky, where he founded an astronomical observatory. The brass-wire line on the floor, representing the meridian, still exists and is shown as a relic of the observatory. There was also a chemical laboratory, in which Tycho worked.

In the year 1600 Tycho Brahe, at the request of the Emperor, again returned to Prague, where, near the Royal Castle on the ground belonging to Curtius, arrangements were made for building an observatory surpassing even that of Uraniburg in character.

Meanwhile a house, "At the Golden Griffin," was provided for him and his family; and his library, together with his twenty-eight astronomical instruments, was removed to the summer castle of Belvedere, which is named after Tycho even now. Some time afterwards his observatory was removed to the ground of Curtius, where the Czernin barracks are now standing. Here he was assisted in his work by the young mathematician Kepler, who was called by the Emperor to the capital of Bohemia "quoad calculum."

While Tycho was in the midst of his scientific activity he was seized by a sudden illness and after eleven days he died. He was buried in the Teyn Church, and at his grave the learned Bohemian Dr. Jesenius delivered an impressive Latin oration in which he described Tycho's scientific merits and noble character.

The celebration of the 300th anniversary of Tycho's death began at Prague on October 18, where, at a special meeting of the Bohemian Academy of Science, Art and Literature, Prof. Gruss read an address on Tycho's life and scientific influence.

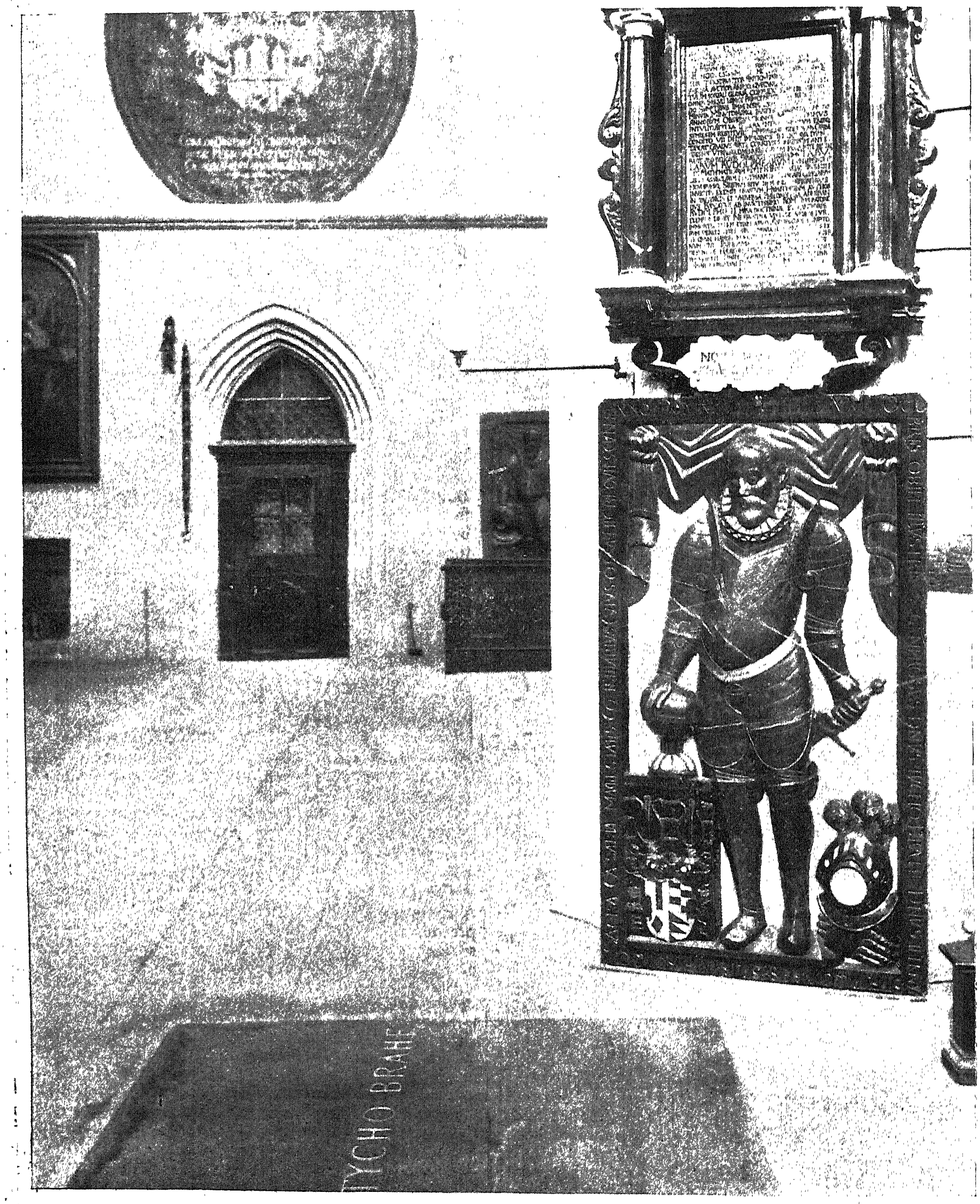
The Royal Bohemian Society of Science celebrated the tercentenary on October 24. In one of the ancient meeting-rooms of the Prague Town Hall an exhibition was held of several Tychonian relics. There was Tycho's magnificent album which was presented by him to his son and is a treasure of antique book-binding; the manuscript, "Triangulorum Planorum et Sphæricorum Praxis Mathematica,"; a manuscript, "Tychonis Brahe Ottonidis (his father's name) Tabulæ Sinuum, 1682"; the memorandum book of Siebold Plan, with an inscription: "Plures sapiunt palato quam cerebro, Tycho Brahe scripsit Uraniburgi, Anno 1591." From Tycho's printed works were exhibited, a copy of Ptolemy's "Almagest," with Tycho's handwriting of 1560; a copy of Copernicus's "De Revolutionibus Orbium Cœlestium Libri VI.," with Tycho's margin notes; a copy of "Tychonis Brahe Astronomiæ Instauratæ Mecanica, Wandesbergi, Anno MDIIC.," which contains Tycho's signature and a dedication to his friend Baron ab Hasenburg, a book containing *inter alia* extremely interesting coloured pictures of the Uraniburg and of a series of Tycho's astronomical instruments. Several other books from Tycho's library bearing dedications to him were also exhibited. All these objects are described in Prof. Studnička's work, "Prager Tychoniana," of which a notice has appeared in NATURE (vol. lxiii. p. 206). There was also exhibited Tycho's Latin poem on the title-leaf of the book, "Prutænicæ Tabulæ Cœlestium Motuum Autore Erasmo Reinholdo"; and a celestial globe made by Tycho's pupil, Willem Iansoon Blaev, in 1603, and containing the positions of fundamental stars as determined by Tycho. Many photographs of Tychoniana were exhibited; some of them, showing the present state of Uraniburg after recent excavations, were contributed by Prof. Thiele. The books and the globe lent for exhibition were from the monastery of Strahov, the Royal Bohemian Museum, and the Imperial Library of the University.

Among those who attended the celebration were Dr. Thiele, professor of astronomy in the University of Copenhagen and rector of the latter, as a representative of the University and of the Danish Academy of Sciences, with his son and assistant, Holger Thiele; Mr. Harald Mortensen, of Copenhagen; and a great number of representatives of Bohemian science. After visiting the exhibition, the representatives went to the Town Hall, where they were received and greeted by the Mayor of Prague. Prof. Studnička then gave an address of the life and work of Tycho Brahe. The meeting was brought to a close by a few historical remarks by Prof. Tomek, the distinguished historian of the city of Prague and president of the Royal Society of Bohemia.

After this a visit was made to Tycho's tomb and monument in the Teyn Church, opposite the Town Hall. It must be remarked here that this church was partly destroyed by fire in 1675 and that its pavement was restored in 1721. It was therefore doubtful whether Tycho's remains would be found there, especially as, after the battle on the White Berg in 1620, the Teyn Church became a Catholic one and the bodies of persons who had held other beliefs were removed. The municipality of Prague, in view of the anniversary, had this question fully investigated by Profs. Schrutz and Matiegka, and it was found that the brick vault of the tomb had been broken during the catastrophes of the seventeenth and eighteenth centuries and that some earth had fallen in. Two bodies were, however, brought out with the greatest care, and it was recognised by many signs, such as the form of the moustache and the fact that a part of the nose had been cut off and replaced by one of metal (chiefly copper), that the skull undoubtedly belonged to Tycho, whose nose was cut off in a duel in 1566, so that he afterwards wore an artificial nose of metal.

The tomb was put in good order and the remains of Tycho and his wife were placed in a metal coffin and again buried. The grave is covered by a large marble plate bearing the inscription, "Tycho Brahe." The tomb and epitaph are represented in the accompanying reproduction of a photograph. As it appears that one of the authors of the inscription on the epitaph was Kepler, we give it here in its full length:—

"Esse potius quam videri.
Illustris et generosus Dominus Tycho Brahe, Danus, Dominus in Knudstrup, arcis Uraniburgi in insula quissima nobilitate clarus, suo auctior animo, quæcunque cœlo continentur, immortali gloria complexus, Astronomorum omnis sæculi longe princeps, totius orbis



Tomb, Tombstone and Epitaph of Tycho Brahe at Prague.

Hellesponti Danici Huenna fundator, instrumentorum astronomicorum qualia nec ante sol vidit, ingeniosissimus idemque liberalissimus inventor et exstructor, anticommodo sumptibus immensis, exactissimas intra minuta minutorumque partes, triginta amplius annorum observationes mundo primus intulit; affixa sidera intra minutum

ejusque semissem restituit: Hipparchi solius ab orbe condito vel diis improbos in octava duntaxat gradus parte conatus longissime antegressus: utriusque luminaris cursum exquisite restauravit, pro reliquis erraticis solidissima *tabularum Rudolphaearum* fundamenta jecit: Mathematicarum rerum peritis inveteratam Aristotelis et asseclarum doctrinam de sublunari cometarum novorumque siderum situ, demonstrationibus invictis exemit: novarum hypothesium autor; in Stagyricis et universa philosophia admirandus; evocatus ab invictissimo Romano imperatore *Rudolpho Secundo*, mira doctrinæ et candoris exempla dedit; ne frustra vixisse videretur, immortalitatem, etiam apud Antipodas scriptorum perennitate sibi comparavit; planeque qualis esse quam haberi maluit, nunc vita functus æternum vivit.

Ejus exuvias uxorisque triennio post defunctæ heredes liberi sacro hoc loco composuerunt. Obiit quarto kalend. Novembris anni Christiani Dionysiaci MDCI ætatis suæ LV.

Non fasces, nec opes, sola artis sceptra perennant." Around the tombstone bearing Tycho's likeness we read: "Anno Domini MDCI die XXIV Octobris obiit illustris et generosus Dominus Tycho Brahe, Dominus in Knudstrup et Præses Uraniburgi et sacræ Cæsareæ Majestatis Consiliarius, Cujus ossa hic requiescunt."

When the visit to Tycho's tomb took place, the Mayor of Prague laid a beautiful wreath upon the tomb which bore the inscription upon ribbons in national colours, "To the great philosopher—the Royal Capital of Prague." Other wreaths bore the inscriptions, "Universitas Hafniensis," "Societas regia scientiarum Danica," "Fra Danske Studenter." There were also wreaths from Prof. Šafařík, the Observatory of Prague, and many others from literary and scientific societies.

The visitors afterwards proceeded to a house on the "Fruit Market," where a memorial tablet of marble was placed stating that Kepler lived there from 1604–1607. In the afternoon the Belvedere of Tycho Brahe was visited and a name "Tycho Street" was given to a new street opposite it. The long row of carriages bearing the numerous visitors then proceeded to a quiet street near the now abandoned Royal Castle, and the house "At the Golden Griffin" was shown, having in front a marble tablet stating that Tycho lived there in 1600 and 1601. Finally, the place was visited where Tycho's last observatory formerly stood and where a new street, bearing the name of Kepler, is now situated.

In this way was celebrated the memory of the great astronomer whose work marks a great epoch in that science, and from whose observations his friend and colleague Kepler calculated his well-known laws.

BOHUSLAV BRAUNER.

CELEBRATIONS IN DENMARK AND SWEDEN.

In Copenhagen the Society of Science celebrated the tercentenary of Tycho Brahe's death in the presence of the King and Royal family and all the members of the Society. The meeting was opened with a short address by the president of the Society, Prof. Jul. Thomsen, who announced that Dr. J. L. E. Dreyer, who was born in Denmark, had had the order of Knight of the Dannebrog conferred upon him by the King. Prof. Fridericia gave a lecture on the personality of Tycho Brahe. He pointed out his scientific enthusiasm and his accurate observations, and showed how towards the close of his life he neglected the mystical side of astrology and regarded astronomy more from the physical point of view. The astronomer's statue in the grounds of the Copenhagen Observatory was decked with wreaths and flowers.

At the University of Lund a bust of Tycho Brahe was unveiled. The Stockholm Academy of Science celebrated the event by a memorial festival in the presence of Prince Eugen and several of the ministers, when speeches were delivered by President Odhner and Prof. Dunér.

STUDIES ON THE ETHNOGRAPHY OF THE NORTH QUEENSLAND ABORIGINES.[1]

ANTHROPOLOGISTS so fully recognised the value of Dr. Walter E. Roth's "Ethnological Studies among the North-West-Central Queensland Aboriginals" that there was considerable satisfaction when the news arrived a year or two ago of his appointment as Northern Protector of Aboriginals in Queensland. We now have the pleasure of receiving two *Bulletins* on North Queensland ethnography, which are the first-fruits of that able investigator's researches in his new sphere, and at the same time we must thank and compliment the Home Secretary's Department in Brisbane for issuing these *Bulletins*, especially as we are promised two or three similar *Bulletins* annually. Dr. Roth expresses his deep indebtedness to the Hon. J. F. G. Foxton for all the kindly encouragement invariably received from him during the prosecution of his scientific labours, and it is due to his wishes, as ministerial head of the Department, that these researches of Dr. Roth's are now being made available to the public. Dr. Roth has anticipated the thanks which anthropologists at home would like to offer to this public-spirited Minister. Publications such as these will do something towards reducing that ignorance of our native races which is largely due to the apathy of our Government as a whole.

The first *Bulletin* consists of an essay by Dr. Roth on "String, and other Forms of Strand: Basketry-, Woven bag- and Net-work." The animal and vegetable products of which strings are made are enumerated, and Mr. F. M. Bailey, the Colonial botanist, has identified the plants from which textiles are made which have been collected by Dr. Roth. The method of making string, including the manufacture of human-hair twine, is fully described and illustrated. Dr. Roth gives in his short direct style accounts of the procedures in which string and other forms of strand are employed. His classification of the processes of construction of basketry, woven bags and network will prove of considerable value to those who have to describe similar textiles from other countries. His explanations are illustrated by nearly a hundred clear diagrams drawn by the author and contained in nineteen plates.

The second *Bulletin* is devoted to the structure of the Koko-Yimidir language, in which Dr. Roth has had the invaluable cooperation of the Revs. G. H. Schwarz and W. Poland, Lutheran missionaries at Cape Bedford Mission Station. This language is spoken from the Annan and Endeavour Rivers to the northern side of Cape Flattery. It is noteworthy that this Koko-Yimidir language is the identical one of which Lieutenant Cook took a vocabulary when visiting the Endeavour River in 1770. A table is given of Cook's words with those in use at the present day; the "kanguroo" of the great voyager is still spoken of as *ganguru*. There are many suggestive notes on the language apart from the interest of the language itself.

We have no doubt that the succeeding numbers will be as valuable as those now to hand, and we shall eagerly await the good things which we are sure Dr. Roth has in store for us.

CHARLES MELDRUM.

DR. CHARLES MELDRUM was born at Kirkmichal, Banffshire, in 1821, and died in Edinburgh in August 1901. He was educated at Aberdeen University, and after graduation as Master of Arts he joined the Bombay Education Department. In 1848 he was appointed professor of mathematics in the Royal College

[1] "North Queensland Ethnography." *Bulletin* No. 1, C.A. 11–1901, price 8s.; No. 2, C.A. 22–1901, price 1s. (Brisbane: by Authority, Edmund Gregory, Government Printer, William Street, 1901.)

of Mauritius, and soon thereafter turned his attention to meteorology, of which he continued to the end one of its most ardent students. It was chiefly by his influence and exertions that the Meteorological Society of Mauritius was founded in 1851, he being its first secretary. He was appointed Government Meteorological Observer in 1862 and Director of the Royal Alfred Observatory in 1875; and in recognition of the great public services he had rendered to the colony he was made a member of the Government Council of Mauritius. For his services to science, more particularly to meteorology, his own University of Aberdeen conferred on him the honour of LL.D.; in 1874 he was elected a F.R.S.; and in 1886 he was honoured with a C.M.G.

Meldrum was a man of untiring energy and perseverance, and to this was added the keenest perception of the absolute necessity there was to replace theoretical speculation by accurate observations in all attempted solutions of the problems of meteorology. In carrying on this large and irksome work he soon displayed a genius in devising the methods for obtaining the physical data required for the investigations he took in hand. His self-devotion to the work was unsparing and unremitting to the end.

His first notable contribution to science was in the attractive field of practical meteorology, by which signal service was rendered to the forecasting of storms within the tropics. The data collected for the purpose was of a twofold nature. First, he clearly saw the paramount importance of a statement of the hourly variations through the months of the year of the pressure, temperature, wind and cloud, and to arrive at which he early instituted "Term Day Observations" as part of the systematic work of the Observatory. In a year or two, approximate hourly averages were thus obtained, and, from these averages, deviations were at once apparent from the regular normal hourly march of the pressure, temperature, wind and cloud.

In the second place, a unique and rich collection of maps of the cyclones of the Indian Ocean began to be prepared from the Mauritius observations, combined with observations obtained from ships' logs, on which isobars, isotherms, winds and clouds were entered, thus depicting from strict observations the outstanding features of the cyclones and gales of the Indian Ocean. In a valuable paper read to the British Association at Dundee, it was shown that the gales and hurricanes of the Indian Ocean south of the equator were conveniently grouped into three distinct types: (1) trade-wind gales, in which the wind veers little, these occurring chiefly in the winter months of June, July and August, when the S.W. monsoon prevails north of the equator; (2) the extratropical gales, occurring south of lat. 30°, in which the wind veers or shifts, these storms being somewhat analogous to the storms of north-western Europe and are most frequent and violent from May to August; and (3) the tropical hurricanes, or true cyclones, in which the wind always veers. It was to this last class that Meldrum mainly directed his attention.

A strict and extended inquiry was carried on respecting the relations between the course pursued by individual cyclones and their changing intensity, and the deviations from the normal values of pressure, wind, &c., observed at the Observatory. The inquiry resulted in showing unmistakably (1) that the direction in which the cyclone was from Mauritius could be readily known from the wind; (2) that its distance from Mauritius could be known from the amount of fall of the barometer and the rate of the fall, taken in connection with the variations in humidity, wind and cloud; and (3) that its progressive motion could be known chiefly from the veerings of the wind. These novel conclusions were soon put to practical use in sending to the daily Press prognostics of cyclones which were attended with complete success. This great result was all the greater inasmuch as it showed that what was done at an isolated station in the ocean might equally be done with success at sea.

In 1874 he submitted another important paper to the British Association at Belfast, "The Cyclone and Rainfall Periodicities in connection with the Sun-spot Periodicity," and in several subsequent years he returned to the same subject. He was one of the earliest workers in this attractive department of science, and his contributions, more particularly as regards the rainfall drawn from all climates, were alike remarkable for the enormous labour involved in their preparation and the lucid clearness with which they established and presented the intimate connection subsisting between the sun-spots and the cyclone and rainfall periodicities.

The Observatory of Mauritius stands second to no other Observatory in the world for the excellence of the physical data it has supplied towards the investigation of these periodicities. As regards the prime elements of climate its records afford the requisite data for the last four complete sun-spot periods from 1855 to 1888, and also the annual number of cyclones in the Indian Ocean from 1847 to 1900, or fifty-four years in all. The following table gives a comparison of the periodicities of the rainfall, pressure, temperature and cyclones. The figures for the rainfall, pressure and temperature are given as differences from their annual averages, the differences being "bloxammed" in the usual way.

Year of sunspot period.	I.	II.	III.	IV.	V.	VI.	VII.	VIII.	IX.	X.	XI.	Average.
Sunspots, 1855–1888	10	5	18	49	90	90	84	63	45	29	20	
Rainfall, inches	−1·3	1·2	−0·4	0·4	−1·2	2·5	3·9	5·5	−1·3	−3·5	−5·5	46·9
Pressure, 1000th of an inch	1	1	3	7	11	−1	−7	−10	−4	−2	3	30·069
Temperature, degrees	0·1	−0·1	−0·3	−0·5	−0·3	0·0	0·2	0·3	0·4	0·3	0·2	73·6
Indian Ocean cyclones, 1847–1900 ...	5	3	5	8	12	10	10	10	8	7	5	8

The result shows an intimate connection between the prime elements of meteorology and the sun-spot variation.

In 1866 Dr. Meldrum visited England, one of the chief objects in view being to obtain a complete set of magnetical and meteorological registering instruments suitable for a first-class observatory. These were received in course, and by the end of 1874 were installed, and at work, in the new Royal Alfred Observatory, of which he was appointed the first director. The results have been published in the Annual Reports since, and in the Report for 1899 Mr. Claxton has begun to give the larger results of the work of this Observatory, beginning with the diurnal variation of the atmospheric pressure deduced from twenty-five years' observations (1875–99), and of some of the other chief elements of climate for shorter terms of years. These results are simply of inestimable value, not only to men of science, but also to navigators.

Some time ago there was added to the regular routine of the Observatory the taking of photographs of the sun when the weather permitted. The number of photographs taken in 1900 was 377; they have been

transmitted to Sir Norman Lockyer, director of the Solar Physics Observatory, South Kensington.

In consideration of the valuable work so minutely and ably carried on at this Observatory in the departments of meteorology, general physics and magnetism, the publication *in extenso* of these daily and hourly observations becomes a question of national importance, in view, especially, of the large results now in course of evolution.

ALEXANDER BUCHAN.

NOTES.

THE presidential address delivered by Mr. Charles Hawksley at the Institution of Civil Engineers on Tuesday was very comprehensive in its scope. Being the first inaugural address delivered at the Institution since the commencement of the new century, the opportunity was taken of giving a retrospect of advances made in the past century in the more prominent branches of civil engineering. At the commencement of the nineteenth century engineering works were comparatively few in number. Railways, steamships, electric telegraphs, telephones, the use of electricity for lighting and motive-power, were all unknown. Lighting by means of coal-gas had only just been introduced, and even the steam-engine was then in a primitive stage. Looking backward, and comparing the condition of things a hundred years ago with the present state, the changes which science and invention have brought about certainly appear remarkable. But it is advisable not to rest satisfied with a complacent view of the progress made. There is a prospect as well as a retrospect, and it is essential to push forward into the new fields of work before they are occupied by other nations. This is the lesson which must be impressed upon the minds of the British people, and used to give their political leaders a sense of responsibility for national welfare in the future. Engineers are not usually inclined to accept the view that action is necessary if we are not to be beaten in the industrial war which is now going on, but Mr. Hawksley acknowledges that "British engineers and manufacturers cannot hope to possess in the twentieth century that practical monopoly which they enjoyed during a considerable part of the nineteenth century." The conditions have changed, and unless our engineers and manufacturers adapt themselves to the new environment they will be superseded by men of other nations more in touch with the times. Mr. Hawksley mentioned in his address the serious difficulties and disadvantages under which British manufacturers are placed by the lack in this country of acknowledged standards. A committee formed to consider the subject in June last decided unanimously that it was desirable to issue standard sections and standard specifications, and the Institution of Civil Engineers has taken the work in hand. Four committees dealing with different branches of industry have been formed and are now at work standardising the various sections used in engineering practice.

THE death is announced of Prof. Ralph Tate, F.L.S., F.G.S., professor of natural science in the University of Adelaide, South Australia. Tate was a naturalist of the old school, with a good knowledge of botany, field zoology and geology. His earliest researches were carried out in the neighbourhood of Belfast, and he published papers on the Lias and Cretaceous rocks in the *Quarterly Journal* of the Geological Society. In 1864 he was appointed museum assistant to that Society, a position which he occupied for about four years. During this period and up to the year 1876 he devoted his attention mainly to the Mollusca and especially to the Gasteropoda of the Lias. In conjunction with Prof. J. F. Blake, the well-known "Yorkshire Lias" was published in 1876. In that year Tate left England for the University of Adelaide, and henceforth his labours were devoted to the geology and natural history of Australia. In 1893 he was elected president of the Australian Association for the Advancement of Science. His later contributions to science dealt chiefly with the Tertiary Mollusca of Australia.

DR. A. H. BENNETT, only son of the late Prof. John Hughes Bennett, of Edinburgh, and author of several works relating to diseases of the nervous system, died on Friday last at the age of fifty-three.

AT the ordinary quarterly comitia of the Royal College of Physicians, held last week, it was resolved to send delegates to the congress on medicine to be held at Cairo in December 1902, and also to the International Congress in Medicine, to be held in Madrid in April 1903. A proposal from Mrs. FitzPatrick to found a lectureship in the college, accompanied by a draft for 2000*l.*, was accepted, and it was resolved to send the following expression of thanks on vellum and sealed with the College seal:—"The President and Fellows of the Royal College of Physicians of London, in comitia assembled, tender their cordial thanks to Mrs. FitzPatrick for her munificent gift of 2000*l.* for the purpose of endowing a lectureship on the history of medicine in memory of her late husband, Dr. Thomas FitzPatrick, a member of the college; they gratefully accept the same and undertake faithfully to administer the trust she has committed to them."

IT is stated by the Berlin correspondent of the *Times* that Prof. Paul Ehrlich, of Frankfurt-on-the-Main, has been enabled to devote himself to a special study of the disease of cancer in consequence of a bequest of the interest for three years of a sum of 500,000 marks dedicated to this purpose by a Frankfurt banker, the late Herr Theodor Stern. Other sums contributed by private individuals will bring up the amount to be devoted to this special investigation of cancer by Dr. Ehrlich to 40,000 marks, or 2000*l.* a year. In Berlin there exists a special committee for the investigation of cancer, which studies pathological accounts of cases and collects statistics and medical literature on this subject. Prof. von Leyden is at the head of the committee, and Prof. von Kirchner, of the medical department of the Ministry of Public Instruction, is one of its members.

MR. NORTHCOTE THOMAS has been appointed organising secretary to the Society for Psychical Research.

THE biennial dinner of the Physical Society of London will be held at the Hotel Cecil on Friday, November 15.

THE Christmas course of six lectures to young people, at the Royal Institution, will this year be delivered by Prof. J. A. Fleming, F.R.S. The subject will be "Waves and Ripples in Water, Air and Æther," and the first lecture will be delivered on Saturday, December 28.

THE new session of the Institution of Electrical Engineers will be opened on Thursday, November 21, when the premiums awarded for papers read or published during the session 1900–1901 will be presented, and the president, Mr. W. Langdon, will deliver his inaugural address.

THE Siberia-Oriental Section of the Russian Imperial Geographical Society will celebrate the fiftieth anniversary of its foundation on November 17/30.

THE scientific committee of the Aëro Club of Paris has decided to award the Deutsch prize of 100,000f. to M. Santos Dumont.

AN illustrated public lecture on Jamaica was delivered at the Imperial Institute on Monday by Mr. Herbert Thomas, who had resided continuously for the last twenty-five years in the island. In describing the principal products of the island, Mr.

Thomas said that the lamentable decay of the sugar industry could not be more forcibly illustrated than by the fact that whereas at the beginning of the nineteenth century 800 sugar estates had been under cultivation, there are now only 125. Even Jamaica rum is in less demand than formerly, having been largely superseded—even in the island itself—by whisky. On the other hand, the fruit trade of late years has made great strides; its value was 40,000*l*. in 1879 and 635,000*l*. in 1899. Tobacco is a product with a great future in store for it; also cocoa, the cultivation of which has recently largely increased and its quality improved.

THE conviction having arisen in the minds of many members of the American Philosophical Society that the time has come when the interests of useful knowledge in the United States can be greatly promoted by the holding, in addition to the Society's usual fortnightly meetings, of at least one general meeting in each year, the Society has authorised the holding of a general meeting in Easter week of next year, and a committee has been appointed to make the necessary arrangements. Members desiring to present papers, either for themselves or others, are requested to send to the secretaries at as early a date as practicable and not later than February 15, 1902, the titles of the papers, accompanied by a brief abstract, so that they may be duly announced on the programme, which will be issued immediately thereafter and which will give in detail the arrangements for the meeting.

THE "Chemical Society's Memorial Lectures," delivered between 1893 and 1900, have been published in a separate volume, which can be obtained from Messrs. Gurney and Jackson. There are twelve lectures in the volume, most of them important contributions to the history of chemistry and all of interest as descriptions of work to which the progress of modern chemical science is largely indebted. Several of the lectures were reported or abridged in these columns when they were delivered. The twelve chemists whose scientific careers are reviewed in the lectures, now rendered available in a convenient form, are Stas, Kopp, Marignac, Hofmann, Helmholtz, Lothar Meyer, Pasteur, Kekulé, Victor Meyer, Bunsen, Friedel and Nilson.

WE have received from the Home Office a copy of Dr. Le Neve Foster's general report on the minerals raised in the United Kingdom during 1900, and therein we learn that the value of the output, exclusive of the product of shallow quarries, was no less than 135,957,676*l*., or nearly thirty-eight and a half million pounds more than that of 1899. The enormous increase is due partly to the larger quantity of coal produced, the excess being more than five million tons, but it is mainly owing to the higher average price per ton. To coal is due 89 per cent. of the total value of the output of our mines and quarries. Next in importance is iron-ore, the value of which is about four and a quarter million pounds. It is satisfactory to note that gold mining in Wales was carried on with an excellent margin of profit; no less than fourteen thousand ounces of bar gold were obtained, and the value was upwards of fifty-two thousand pounds.

TWO quarterly parts of a catalogue of Polish scientific literature, prepared by the bibliographical committee of the Department of Mathematics and Natural History of the Academy of Science at Cracow, have been received. The catalogue is intended to form a complete current list of Polish publications, commencing with the present year, and including separate works and dissertations, papers in scientific journals, and translations into Polish from other languages. It is also intended as a contribution to the International catalogue of scientific literature now in course of preparation. Each title is given alphabetically in its proper section under the name of the author, and a translation of the Polish title is added in English, French, Latin, German or Italian. The subject classification adopted in each part is as follows:—(A) pure mathematics; (B) mechanics; (C) physics; (D) chemistry; (E) astronomy; (F) meteorology (including terrestrial magnetism); (G) mineralogy (including petrology and crystallography); (H) geology; (J) geography (mathematical and physical); (K) palæontology; (L) general biology; (M) botany; (N) zoology; (O) human anatomy; (P) physical anthropology; (Q) physiology (including experimental psychology, pharmacology and experimental pathology; (R) bacteriology.

THE Report of the Royal Prussian Meteorological Institute for the year 1900 shows that steady progress is being made in the work of the various departments. The newly erected observatory on the Schneekoppe began to work regularly on June 1, 1900. The investigation of the upper air is actively carried on by means of kites, provided with self-recording instruments; on one occasion a height of 4255 metres was reached. The number of meteorological stations now amounts to some 200, in addition to 2200 rainfall stations; more than 1400 stations report thunderstorms and unusual occurrences either directly or monthly by post-cards. The results of the observations are published in annual, monthly and weekly reports, and the staff is encouraged to contribute discussions to various scientific journals.

THE Meteorological Office pilot chart of the North Atlantic and Mediterranean for the month of November shows that during September there was a rapid diminution in the quantity of ice on the western side of the Ocean, the latest report of a berg eastward of Newfoundland being as far back as September 11. In the strait of Belle Isle and eastward to the 50th meridian large and small bergs were still numerous, but they were noted as greatly thinned out since the previous month. Various local features of the Atlantic winds in November are dealt with, and as regards the ocean currents it is pointed out that at this season the Gulf Stream exhibits a decided slackening in the vicinity of Cape Hatteras, where the maximum velocities are reduced from 50 to 80 miles in October to as low as 30 to 45 miles. This, however, would appear to be a local check, for to south and north the rates are but slightly altered. On the African coast, between Capes Blanco and Palmas, a distance of more than 1000 miles, there is a westerly to north-westerly current setting away from the land. Mariners are cautioned as to the dangers from wrecks and derelicts, and particularly near the American coast, some portions of which are studded with sunken wrecks. A similar caution is given as to rollers down the west coast of Africa, which sometimes break with great violence in from nine to three fathoms. A new feature of the chart is the monthly discussion of the paths of barometric depressions affecting the Mediterranean. In November there are three main lanes each having its own influence on the winds experienced. The principal one proceeds from the Bay of Biscay across Corsica to Asia Minor, but another important one enters from the south-westward by the Strait of Gibraltar, or further north, passing across Sardinia and Italy, influencing the weather of the western basin, being the primary cause of the severe northerly and north-westerly gales there experienced. Both series of disturbances exhibit a tendency to lag on nearing Italy. The third group of depressions appears to traverse Algeria and Tunis, to enter the Mediterranean about the Gulf of Kabes, and move eastward across Cyprus.

THE autumn of 1899 was marked in the United States by a great development of the fall army-worm (*Laphygma frugiperda*), which probably was as injurious as any other insect that season, being destructive to a great variety of crops over a large

area. In *Bulletin* No. 29 of the entomological division of the U.S. Agricultural Department, Mr. F. H. Chittenden gives an account of this visitation and also of the life-history of this pest, as well as of the variegated cut-worm. The account of the former is the fullest hitherto published, but the sudden disappearance of the insect as a pest in 1900 prevented observations from being taken to complete its history. It is considered probable that the sudden destruction of this and other insect pests of apparently southern origin is due to peculiar atmospheric and other conditions in the late autumn. When the northern localities are restocked the following season, it appears to be owing to an influx of moths from the south.

WE have received two *Bulletins* (Nos. 28 and 30) from the Entomological Division of the U.S. Department of Agriculture, the one dealing with "Insect Enemies of the Spruce in the North-east" and the other recording some miscellaneous results of the work of the Division. Dr. A. D. Hopkins is the author of the former, while Dr. L. O. Howard and several other writers contribute to the latter. It appears that in New England and adjacent territories the valuable forests of red spruce (*Picea rubens*) have during the greater part of the last century been in a very unhealthy condition, numbers of trees dying over large tracts. The chief cause of the mischief is a beetle, described as a new species under the name of *Dentroctonus piceaperda*. After describing the life-history of this pest, the author suggests various remedies for checking its ravages. The more important contents of the second *Bulletin* include a dissertation on the ravages of the "differential grasshopper" in the Mississippi delta, experiments on insecticide, the carriage of disease by flies, the invasion of the codling moth in Idaho during 1900, and the influence of the weather on insect life in the same year. Mr. F. H. Chittenden, the author of the last-mentioned memoir, previously hazarded the suggestion that certain northern forms would continue to flourish after protracted cold weather, which would probably prove fatal to southern types invading the area under observation, and this prediction has been to a considerable extent verified. Both *Bulletins* are well illustrated, the plates in No. 28 being exceptionally good.

IN No. 8 of the *Bulletin* of the Royal Belgian Academy for the current year, M. Julien Fraipont publishes the first instalment of a re-exploration of the Engihoul cavern, Engis, carried out with the assistance of the "Elizabeth Thompson fund." In this communication the author describes the remains obtained from a bears' resort. These are provisionally assigned to *Ursus arvernensis*, *priscus*, *spelaeus*, *ferox* (=*horribilis*) and *arctus*. From comparison with the skull of a large brown bear from the Asiatic coast of Bering Strait, the author makes the suggestion that all these forms may eventually turn out to be specifically inseparable from *U. arctus*.

IN the October issue of the *American Naturalist* Prof. W. M. Wheeler brings to a close his dissertation on the compound and mixed nests of American ants, to which allusion has been made on two previous occasions in our columns. In his concluding paragraphs the author observes: "Wasmann has shown in detail why it is quite unnecessary to assume the existence of anything beyond instinct and simple intelligence in the ants which form compound and mixed nests. I should even be inclined to place a more moderate estimate than Wasmann on the psychical endowments of these animals. . . . Having arrived at the same conclusion as Wasmann, that there are no evidences of ratiocination in ants, we have reached the limits of our brief inquiry. This conclusion, however, even if it be extended so as to exclude all animals except man from a participation in this faculty, does not imply the admission of a qualitative difference between the human and animal *psyche*."

TO the *American Naturalist* Prof. Bashford Dean communicates some highly interesting notes on living nautili from the strait between the islands of Negros and Cebu in the southern part of the Philippine group. Hearing that these cephalopods were commonly captured by the inhabitants of those islands, Prof. Dean paid a visit to Negros, but as the time of year was not propitious he succeeded in obtaining only a few examples. In June, which is the best season, as many as twenty specimens are occasionally taken in a single fish-trap. These fish-traps, of which examples are figured by the author, are sunk by the fishermen in deep water (from about 225 to 350 fathoms), and the nautili are taken in considerable numbers. Not that they are an object of the fishery, for although their flesh is eaten it is but little esteemed, and the shells have till recently found little sale, although matters are improving in the latter respect. Prof. Dean gives several figures of the shell, with and without the soft parts, and shows how male are distinguishable from female specimens by the form of the aperture. Twenty hours was the longest time a specimen was kept alive. Nautili in this region appear to have a definite breeding-season, during which the author thinks it probable that the natives not unfrequently obtain eggs. Our readers will recall a description of nautilus eggs from New Guinea by Prof. Willey which appeared in our columns in 1897.

THE first part of a new Cryptogamic Flora of Germany, by Dr. W. Migula, has been issued, in connection with Thome' "Flora von Deutschland, Oesterreich, und der Schweiz."

DR. A. TOMMASI has sent us a copy of a memoir on a collection of Triassic fossils from the Valle del Dezzo, Italy, recently published in *Mem. Ist. Lombardo* (vol. xix. pt. 4). The fauna seems most nearly allied to that of St. Cassian; but a number of new species of molluscs and brachiopods are described.

THE October number of *Climate* is mainly devoted to the subject of malaria, and has in it a paper by Sir William MacGregor entitled "Malaria and its Prevention," articles on the malaria question, and the West African climate, also the general outlines of a course of ten health lectures, which, at the suggestion of the Governor, have recently been given to sanitary inspectors, hospital nurses, teachers and others at Lagos.

THE *Proceedings* of the Liverpool Geological Society (vol. ix. part 1, 1901) contain important communications by the late G. H. Morton on the Carboniferous Limestone series of North Wales, and of especial interest is his tabular list of the fossils, showing their range in the various subdivisions and their occurrence in the four districts of Llangollen, Flintshire, Vale of Clwyd and Llandudno, and Menai Strait and Anglesey. In the same publication Messrs. T. Mellard Reade and P. Holland deal with the Green Slates of the Lake District and discuss the subject of slaty cleavage. They maintain that real slaty cleavage is always accompanied by mineral changes in the body of the rock, which not only give the foliaceous character, but supply the necessary cement to bind together the overlapping constituents and convert what was originally mud into a rock possessing the tenacious and economically useful properties of slate.

THE clays and clay industries of Wisconsin form the subject of a memoir, by Dr. E. R. Buckley, which is published by the Wisconsin Geological and Natural History Survey (*Bulletin* No. vii., Economic Series, No. 4, 1901). Following the plan adopted in many American works, the author commences with the origin of clay, and passes on to the composition, classification, properties and behaviour of clays in general before he deals with the clay deposits of Wisconsin. These are both residual and transported, the residual clays being due to the decomposition of granite, greenstone, limestone, shale and other rocks. The transported clays are by far the more extensive, comprising

those of glacial, lacustrine, fluviatile and even wind-borne origin. The author describes the methods of manufacturing brick and drain tile, and then proceeds to record in detail his observations on the clays, and the local modes of working and manufactures in Wisconsin. In appendices he notes the methods employed in the examination of the clays in the field and in the laboratory, and he gives numerous analyses. A map and many other illustrations accompany this work.

MESSRS. JOHN WHELDON & Co. announce the publication of the first volume of the "Botany of the Færöes," edited by Prof. E. Warming. The present volume is occupied by the land and freshwater flora (phanerogamic and cryptogamic); the remaining volume will be devoted to the marine flora, to agriculture and gardening, and to other general subjects.

THE publication of the Kew *Bulletin of Miscellaneous Information* has been resumed, with Nos. 175–177, containing instalments of the Diagnoses Africanæ, Decades Kewenses, New Orchids, and Fungi Exotici. The *Bulletin* records, with regret, the retirement of Mr. George Nicholson from the curatorship of the Gardens, in which post he is succeeded by Mr. Wm. Watson. Mr. Nicholson had devoted himself largely to the extension and improvement of the arboretum, and was compiler of the hand-list of trees and shrubs grown in it.

THE *Journal of Applied Microscopy and Laboratory Methods* (published by the Bausch and Lomb Optical Co., Rochester, N.Y.) for October gives a full description, with photographic illustrations, of the botanical laboratory and the botanical garden of the Tokyo Imperial University, Japan. The University buildings comprise a herbarium, library, laboratories, museum, lecture-room, and rooms for a professor and three assistants. Special facilities are given for the study of bacteriology and fermentation. The curriculum for lectures comprises courses in morphology and physiology, in systematic botany, and in advanced physiology. The laboratory work includes courses in classification, morphology, histology, physiology, and embryology, as well as special research work. It is an important feature of the University curriculum that exclusive specialisation is not encouraged. Students who specialise in botany are required also to take courses in zoology, including histology and embryology, geology, palæontology, mineralogy, physiological chemistry, and bacteriology. There are special courses in the agricultural college of the University in forestry and agriculture. The botanic garden has been established for about two hundred and twenty years, and is about five acres in extent. In the same number of the *Journal of Applied Microscopy* is an account, with photographic illustrations, of the course of study in invertebrate zoology in the marine biological laboratory at Wood's Holl.

MESSRS. JORDAN AND SNYDER continue their valuable review of Japanese fishes in the *Proceedings* of the U.S. Museum, the last part we have received dealing with the so-called cardinal fishes (Apogonidæ). Two new species of the typical genus Apogon are described, while a new generic type receives the name *Telescopias gilberti*.

NOS. 1246 and 1247 of the *Proceedings* of the U.S. Museum contain lists, by Messrs. Robinson and Lyon, of mammals and birds recently collected in La Guaira, Venezuela; while in No. 1248 Dr. Stejneger deals with the reptiles and batrachians of the same locality. No. 1250 of the same serial is devoted to a review of the Atherine fishes of Japan, by Messrs. Jordan and Starks. In No. 1252 Dr. Stejneger describes a new bull-frog from Florida; and in the succeeding part Mr. N. Banks treats of certain spiders and other arachnids from Porto Rico.

THE U.S. Department of Agriculture has sent us Nos. 20 and 21 of the "North American Fauna," the former containing a revision of the typical skunks, by Mr. H. A. Howell, and the latter an account of the natural history of the Queen Charlotte Islands and Cook Inlet, Alaska, by Mr. W. H. Osgood. The chief feature in the first article is the proposed substitution of the name Chincha for the familiar Mephitis. In treating of the Queen Charlotte group Mr. Osgood mentions that although a supposed new species of reindeer has been recently described from Graham Island, it is more than doubtful whether any of those animals inhabit the group.

MESSRS. TOWNSON AND MERCER, of Camomile Street, London, E.C., have prepared a series of standard colour tubes—specially for the use of the wine trades—to which purchasers of sherry or other wine may refer any particular sample. As one of the factors in the sale of wine is a certain colour, it will be seen that if a trustworthy standard is established for comparison considerable expense and inconvenience will be saved. It is claimed that the tubes are absolutely permanent in colour and brightness, having been sterilised and made antiseptic, and, so far as we have been able to test it, the liquid in the hermetically-sealed glass cylinder forwarded to us has undergone no change. There is much to be said in favour of these standard tubes. It is much more trustworthy to refer a purchase to an accepted standard colour than to some tint which one endeavours to carry in the eye, or to a stored sample that may have undergone change. It is evident, however, that the range of colour tubes must be fairly extensive, particularly if they are to cover more than one class of wine; must be permanent in tint and brightness; and must have the approval of the wine trades.

THE brief description of the Hammer-Fennel tacheometer given in our issue of October 17 (p. 598) contains a sentence which Prof. Hammer desires to correct. Referring to the use of the instrument, the reviewer remarked:—"The diagram and mechanical adjustments are so arranged that by multiplying the observed displacement of the line from the zero by 20, the difference of altitude in metres will result, while another displacement multiplied by 100 gives the distance." This is not exactly the case. Prof. Hammer informs us that it is "not the displacements of any lines which have to be multiplied, but the section of the rod or stadia contained between the zero-line (horizontal wire) of the diagram and two other points of the diagram; these two points are indicated automatically in the diagram by raising or dipping the telescope."

A PRACTICAL aid to reasonable instruction in geography is provided by the *Geographical Teacher*, the first number of which has just been published. The new periodical is the organ of the Geographical Association (which exists for the purpose of improving the teaching of geography), and it is edited by Mr. A. W. Andrews and Dr. A. J. Herbertson. Mr. Douglas W. Freshfield, president of the Association, contributes an introduction, in the course of which he says that the aim will be to show that the question which Dr. Jowett once put to him, "Can you teach geography so as to make people think?" can be answered in the affirmative. The contributions to the first number substantiate this opinion. Among the subjects are methods of teaching geography, with their limitations and possibilities, the study of maps, geography of the world, photography as an aid to geography, and school excursions. The journal will be published three times a year by Messrs. George Philip and Son.

A TRANSLATION, by Dr. W. H. Thompson, of Prof. Pawlow's lectures on "The Work of the Digestive Glands," embodying the results of researches which were recently awarded the Nobel Prize of 11,000*l.*, will be published immediately by Messrs. Charles Griffin and Co. This edition will include the later volume, entitled "The Experiment," &c., together with the notes of the most recent researches of Prof. Pawlow.

SEVERAL new editions of scientific books of established reputation have recently been received. The fourteenth edition of Naumann's well-known "Elemente der Mineralogie," edited by Prof. F. Zirkel, has been published by Mr. Engelmann, Leipzig (London: Williams and Norgate). The book stands in the first rank of treatises on mineralogy, and is likely to maintain this position while it is so well kept in touch with scientific progress by revised editions.—A similar standard work is Gray's "Anatomy: Descriptive and Surgical," the fifteenth edition of which, edited by Messrs. T. Pickering Pick and R. Howden, has been published by Messrs. Longmans, Green and Co. The entire work has undergone revision, and the section on embryology has been considerably amplified. The volume will thus secure the attention of students for some time to come.—The third edition of Prof. A. H. Church's "Chemistry of Paints and Painting" has been published by Messrs. Seeley and Co. An elaborate and appreciative review of this book appeared in these columns nearly ten years ago (vol. xlv. p. 243). The plan remains the same as in the first edition, but many slight changes have been made and new pigments, or new varieties of old pigments, are described. In the four last chapters Prof. Church gives "adequate evidence of the instability of several favourite pigments largely used by painters in water-colour during the eighteenth and nineteenth centuries."—Mr. Walter Scott has published the third edition of Mr. Havelock Ellis's book on "The Criminal," which was reviewed in these columns when the first edition appeared (vol. xlii. p. 75, 1890). Since then increasing attention has been given to criminal anthropology, and Mr. Ellis gives a valuable statement of the present position of the subject. His book has been enlarged by more than one hundred pages, and much new material has been examined and summarised.

WE have received a copy of Prof. Letts' report on the scheme of sewage purification for Belfast and its probable effects on the Lough. In this report Prof. Letts first deals in a simple way with the chemical nature of sewage and the various methods of sewage disposal. He then deals with the subject of the vast deposits of sea-lettuce (*Ulva latissima*) which accumulate on the Belfast foreshore and, undergoing decomposition, produce serious nuisance. It is shown that the development of the sea-lettuce, which is extraordinarily rich in nitrogen, is associated with the presence of sewage in sea-water and that it thrives wherever an ordinary sewage effluent escapes into sea-water. Coming next to the proposed method of treating the Belfast sewage by double contact with bacteria beds and the discharge of the resulting effluent into the Lough, Prof. Letts concludes from his experiments that the bacteria beds are dispersers rather than converters of nitrogen, that is to say, they liberate a large proportion of sewage nitrogen in the gaseous form. Hence the effluent from such beds is unlikely to stimulate the growth of the noxious green seaweed, and Prof. Letts considers it probable that the proposed system of sewage treatment will eventually suppress the growth sufficiently to put an end to the existing nuisance. In a series of recommendations appended to his report, Prof. Letts suggests the reclamation of large tracts of foreshore and more systematic removal of the decomposing weed. He thinks it probable that by allowing the sewage effluent to flow into tidal ponds containing sea-water and sea-lettuce the nitrogen content might be reduced almost to the vanishing point. The lettuce could be regularly removed and used advantageously as a manure.

THE additions to the Zoological Society's Gardens during the past week include a White-fronted Capuchin (*Cebus hypoleucus*) from Central America, presented by Mr. G. B. Apostoloff; two Syrian Bulbuls (*Pycnonotus xanthopygos*) from Tayif, Arabia, presented by Mr. G. P. Dovey; a Hocheur Monkey (*Cercopithecus nictitans*, ♀) from West Africa, a Simpae Monkey (*Semnopithecus melalaphus*, ♂) from Sumatra, three Ogilby's Rat Kangaroo (*Bettongia penicillata*) from Australia, a Zebra (*Equus* —— ♂), four Young Lions (*Felis leo*, ♂ ♂ ♂ ♂), a Caracal (*Felis caracal*) from Abyssinia, an Indian Antelope (*Antilope cervicapra*), a Ruddy Ichneumon (*Herpestes smithi*) from India, a Goshawk (*Astur palumbarius*), European; five Smooth-clawed Frogs (*Xenopus laevis*) from Africa, deposited; twelve Changeable Troupials (*Quiscalus versicolor*), six Painted Terrapins (*Chrysemys picta*), two American Box Tortoises (*Cistudo carolina*), a Copperhead (*Ancistrodon contortrix*), two Horrid Rattlesnakes (*Crotalus horridus*) from Pennsylvania, three White-eyebrowed Finches (*Zonotrichia leucophrys*), three Lark Buntings (*Calamospiza bicolor*), three Mexican Quails (*Callipepla squamata*), two Painted Box Terrapins (*Cistudo ornata*), five Poinsett's Lizards (*Sceloporus torquatus*, var. *poinsetti*), ix Lesser Horned Lizards (*Phrynosoma modestum*), a Say's Snake (*Coluber catenifer*, var. *sayi*), a Confluent Rattlesnake (*Crotalus confluentus*), two Testaceous Snakes (*Zamenis flagelliformis*), two Western Diamond Rattlesnakes (*Crotalus atrox*) from Pecos, Texas; two Common Rattlesnakes (*Crotalus durissus*), two Couper's Snakes (*Spilotes corais*, var. *couperi*) from Marion co., Florida, received in exchange.

OUR ASTRONOMICAL COLUMN.

THE PERIOD OF ALGOL.—Prof. S. C. Chandler has made a further investigation of the minor inequalities of the period of Algol. These have probably escaped notice up to the present owing to their being so minute as to be of the same order as the errors of observation.

This later inquiry indicates that the deviations of the observed from calculated times of minima have been periodic, distinct changes occurring in the course of a few months, but it does not appear that the periodicity is of a regular character. More frequent and continuous observations of the minima, however, are required to decide this question.

It appears from the curves representing these minor inequalities that the length of the principal of them is about 15,000 periods, this period from the most recent computations being

$$2\text{d. } 20\text{h. } 48\text{m. } 55{\cdot}60\text{s.} +$$
$$3{\cdot}694\text{s. } \sin(133^\circ - 0^\circ{\cdot}024\text{ E.}) + 1{\cdot}784\text{s. } \sin(16^\circ - \tfrac{1}{18}{}^\circ\text{ E.})$$

Tables are then given showing the influence of including these new terms in the comparison of observed with computed epochs of minima (*Astronomical Journal*, vol. xxii. pp. 39–42, 1901.

THE MELBOURNE OBSERVATORY.—The annual report of Mr. P. Baracchi, the Government astronomer at Victoria, has recently been issued. All the usual routine work in astronomy, meteorology, terrestrial magnetism, &c., has been carried on as usual, and considerable progress has been made in the endeavour to lessen the accumulated arrears of unreduced records.

With the astrographic instrument 261 plates have been obtained, including 63 chart triple exposures, 49 chart single exposures, and 39 catalogue plates. The chart series of single exposures of 60 m. is now complete. The new Repsold micrometer made from the designs of Sir David Gill is found to work very satisfactorily, and measurements are made at twice the former speed, dealing with about 170 stars per hour.

The Milne seismograph is now adjusted in position and a continuous photographic record of seismic disturbances will be started as soon as possible.

ROYAL ALFRED OBSERVATORY, MAURITIUS.—The annual report of Mr. T. F. Claxton, director of the Royal Alfred Observatory, has recently been distributed, giving details of progress made during the year 1900. The meteorological and magnetic observations have all been continued as in previous years, but much of the astronomical work with the prime vertical and equatorial had to be abandoned on account of the unhealthiness of the district. Photographs of the sun with the photoheliograph were taken whenever weather permitted, and 311 negatives with 301 prints were forwarded to the Solar Physics Committee.

THE SIGNIFICANCE OF CERTAIN FEATURES AND TYPES OF THE EXTERNAL EAR.

IN these days the search for some characteristic of the human body which will give unequivocal evidence of the mental nature of the individual still goes on as merrily as ever. To some men the bumps of the head tell everything; to others the lines of the palm are hieroglyphic expressions of the qualities of the brain, not to speak of what they tell of things past and events to come; in fact, there is scarcely a feature of the human body that has not, at one time or another, been advocated as an index of certain faculties, and now it is the turn of the external ear. Although not one of these many pretensions has ever stood the test of scientific investigation, or even that of a casual every-day experience, yet their advocates continue to thrive and abound unabated. If those handmaidens of the brain—the muscles of expression—those that set the eye and strengthen the mouth, fail to yield a clue, then it is vain to seek for it in any other structure of the body.

There are three classes of observers, however, which have made a special study of the external ear, deserving of the utmost consideration. The first of these is the school of workers founded by Lombrosa, which believes that *a certain class* of criminals are criminals because of an imperfection in the development of their brains. It is probable, as this school supposes, that such imperfectly developed brains will be wrapped in defective bodies; by the presence of bodily defects, and they have used very largely those of the external ear as an index, the imperfections and unbalanced nature of the brain may be detected. It is clearly a matter of the utmost moment for a State to be able to recognise its criminals, who are criminals because of their constitutional imperfections, and this undoubtedly is the aim of the Lombrosa school. In their investigations of the external ear they found certain features to exist in those of the criminal and insane classes with a much greater frequency than in the sane. With their results I wish to compare a wide series of observations made on the criminal and insane classes of this country.

FIG. 1.—Illustrating certain types of ear ret rred to in the text.

The second class of observers, which deserves attention, is that which has contributed to our knowledge of the development, anatomy and evolution of the human external ear. Its contributions make up quite an extensive literature. Prof.

Schwalbe, who may be regarded as the chief of this class, gives references to 145 papers[1] in his latest work on the ear—most of which deal only with the external ear.

The third class is that of which Bertillon[2] is the chief. To this class the characters of the external ear are important only so far as they may assist in the identification of the criminal. Its system of observation is purely empirical, and the large masses of facts which it has accumulated are useless for the scientific advancement of the subject.

In a paper contributed recently to *La Nature*,[3] from which Figs. 1 and 2 are borrowed, Mr. Henri Coupin remarks that way, for I suspect that most people, as well as the novelist, find a lack of descriptive terms by which the numerous varieties of the external ear may be fully indicated.

There are two types of ear which everyone must have noticed, although they have found no name for them. They are contrasted types and mark the opposite poles of ear development. One of these is that which the novelist occasionally condescends to notice, describing it as "a beautifully modelled, small, shell-like ear." Popularly it is regarded as a sign of high breeding. Examples of this type may be seen in Fig. 1, Nos 1, 5, 8, 11, 18, 20, 25, 27, and in Fig. 2, Nos. 8, 12, 16, 19, 25, 34, 35.

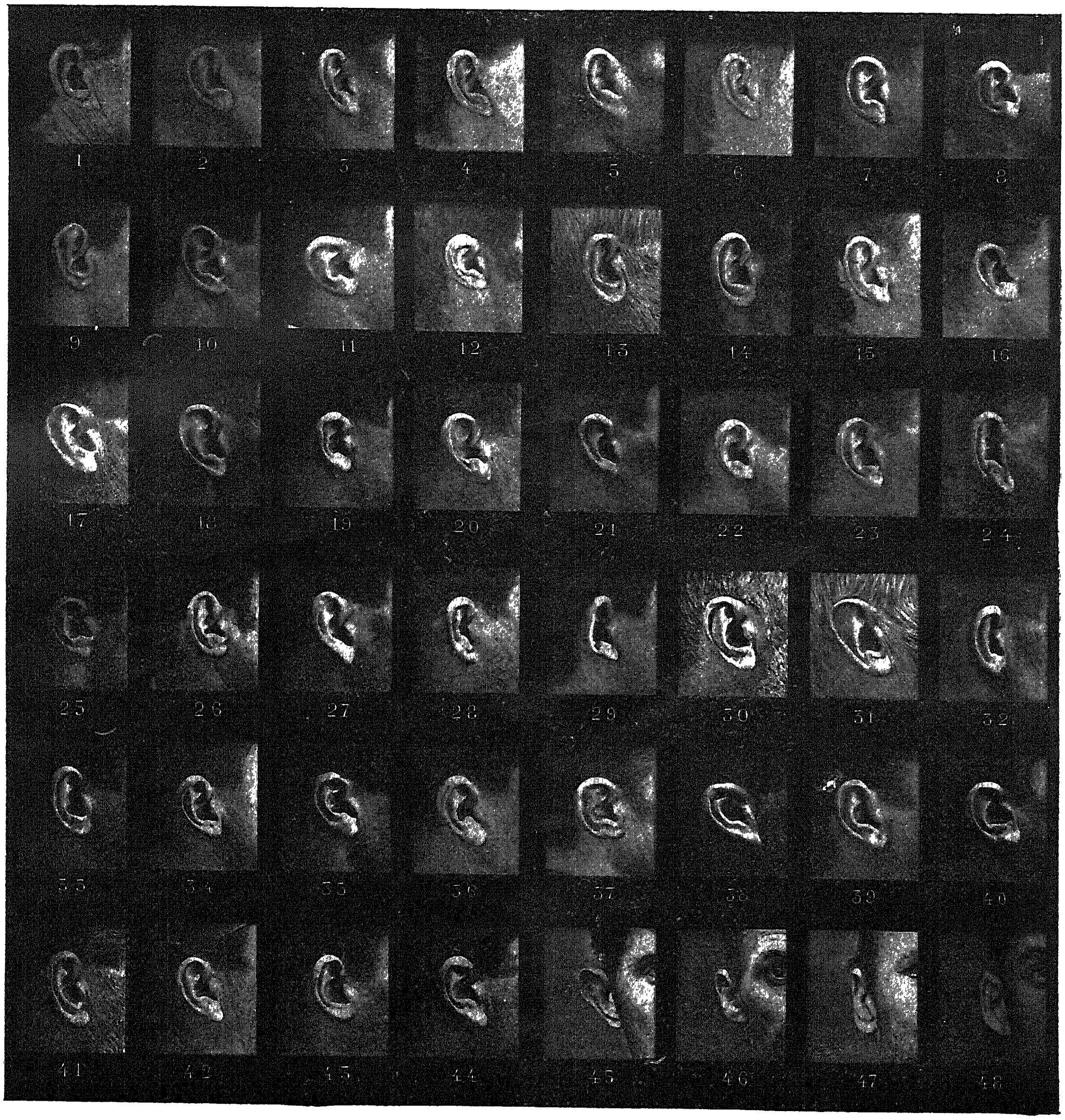


FIG. 2.—Illustrating certain types of ear referred to in the text.

writers of fiction, while describing with a fulness of detail the features of the eye, mouth, nose and hair of the heroine or hero, carefully abstain from any mention of the external ear. Yet there is no doubt that the ear is a subject of common remark among friends and acquaintances, but often in an inarticulate

An example of the same type will be seen in Fig. 3, which is a tracing from a photograph of a typical ear of the orang. For the reason that the chief features of the orang's ear are present in the type of ear I have just cited, I have named it the "orang-type" of human ear.

The type of human ear contrasted to this is one never alluded to in fiction, but is frequently the subject of everyday remark. It is large, expansive, and projects like "wind-sails from the port-holes of a steamer in the tropics." A very good illustration of it is seen in Fig. 2, No. 45, but further examples may

[1] "Handbuchs der Anatomie des Menschen," von Bardeleben. Abtheil ii. Band v., 1898.

[2] "The Bertillon System of Identification." Translated by McClaughry. 1896.

[3] "Notre Oreille," *La Nature*, p. 138, July 27, 1901.

be detected in the same figure, Nos. 13, 17, 31, and in Fig. 1, Nos. 9, 13, 15, 28, 29, 30, 35, 36, 38, 46. An ear of the same type is shown in Fig. 4; it is a tracing from the ear of "Sally," the chimpanzee, and is typical of her species. This may be called the "chimpanzee type" of human ear.

This nomenclature, of course, does not imply that people with the orang-type of ear are related any more to the orang than the chimpanzee-type indicates an affinity to the chimpanzee. The resemblances are due to the fact that in the orang the external ear has undergone marked retrograde changes; in the chimpanzee the ear has retained its pristine development. The one marks

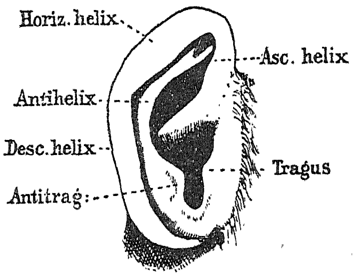


FIG. 3.—An Orang's Ear.

the ebb tide of retrogression, the other the full tide of development; the corresponding types in man mark the same extremes. The anatomical parts of the ears of the three great anthropoids and man are the same (see Figs. 3, 4, 5 and 6), but in men are found types exemplifying the retrograde changes which have overtaken the ears of all orangs, and also examples of the full development which marks the ears of chimpanzees. Curiously enough the gorilla, like man, shows an amplitude in the variations of its ear, but on the whole it inclines towards the orang-type.

But what is meant by retrogression, and what by full development of the ear? The explanation entails a reference to the seven parts which compose the outer ear. Each of the seven springs as a separate part round the opening of the ear in the embryo, and by the fourth month they have fused to form the whole structure.

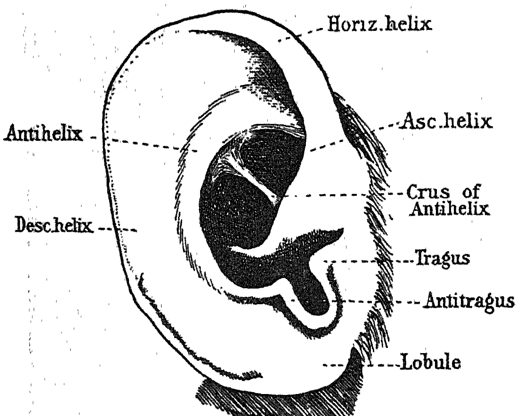


FIG. 4.—Ear of Chimpanzee.

Three of these parts surround the concha, or cavity, and opening of the ear-passage, viz. the tragus, the antitragus and the antihelix (see Fig. 5). The remaining four parts form the circumference of the ear, viz. the ascending helix—in front and above; the horizontal helix—above; behind, forming the wide posterior border of the ear—the descending helix; and below—the lobule. Now only one of these seven parts suffers *markedly* from progressive or retrogressive changes, and that is the descending helix. In Fig. 5 a human ear is represented—somewhat diagrammatically with the descending helix fully developed; that is to say the descending helix is wide, expansive, and its margin is not inrolled; the ear of the chimpanzee (Fig. 4) shows similar characters in its descending helix. On the other hand, the orang's ear (Fig. 3) shows the descending helix not only markedly reduced, but its margin, like that of a cankered leaf, is inrolled. A reference to the orang types in Fig. 1 (such as No. 11) and Fig. 2 will show inrolling of the margin of the descending helix, similar to that in the orang. The various degrees to which the inrolling may be carried is shown diagrammatically in Fig. 5. Four degrees of inrolling are recognised, viz. 0, 1st, 2nd or 3rd degree. It should be remarked, however, that the reduction in size of the descending helix and inrolling of its margin do not constitute all the characters of the orang type—with these the development of the ear as a whole also shows reduction in size. The height of the ear of a chimpanzee is nearly twice that of an orang, yet the orang is the larger animal of the two.

There is one prevalent conception of the human ear which I believe to be a mistaken one, and which I wish to correct now. It is usual to speak of it as a decaying structure. This is remarkable, if true, for with the introduction of speech the means of catching sound are more needed than ever. Although the helix, especially the descending helix, which in mammals generally makes up the greater part of their trumpet-shaped ears, has undergone and is undergoing retrogression in man, that part of the ear which bounds and deepens the concha, the antihelix (Fig. 5), has reached a development in man which it never had before. At least, no other primate shows such a development. That is the change which appears to be going on in man now,

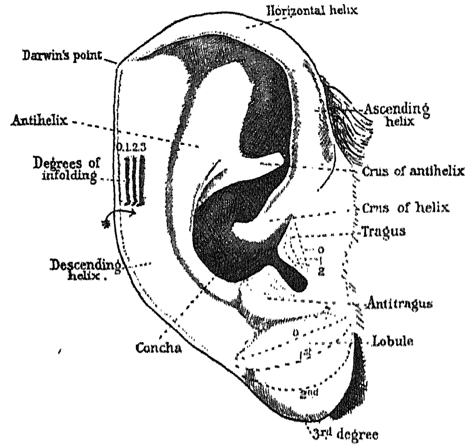


FIG. 5.—Diagram of the human ear.

viz., that in him a new type of ear is being evolved in which the antihelix plays the chief part in collecting sound-waves, while the circumference—the outer helix—undergoes retrogression. In this the orang-type of the human ear differs from the ear of the orang; in the orang the antihelix is in as retrograde a condition as the other parts of the outer ear, even the crus of its antihelix is only occasionally developed (Fig. 3); in the orang-type of the human ear the antihelix is especially well developed.

I should like to proceed at once and inquire into the relationship which those two types of human ears bear to the mental bias of the individuals in which they are found. But in order to avoid the mistakes made by the followers of Lombrosa on the Continent, it is necessary to allude to certain factors which have a powerful influence in determining the type of the external ear. I need not allude to age; that influences shape to some extent, but its effect is principally on its size. Schwalbe found that, on an average, the length of the ear increases 20 mm. from the twentieth to the eightieth year and the breadth at a corresponding rate. The ears of old people are always large and hence in my statistics I excluded those over sixty. This increase is a factor which those who use the ear for identification purposes should remember more than they do.

Sex is a powerful factor. The following table (table 1), in which are given the number of ears observed, the locality in which they were observed, the sex of the individual and the percentage in which the orang- and chimpanzee-types of ear occurred, will show its influence.

TABLE I.

Place.	No. of observations. Male.	Female.	Orang-type. Male. Per cent.	Female.	Chimpanzee-type. Male. Per cent.	Female.
Aberdeenshire	1135	776	27	40	14	5
London, E.	700	492	17	44	13	2
Jews (London)	109	62	16	51	17	8
Kerry	281	205	18	41	34	1
Carmarthen	296	256	18	48	19	6
Peterborough	306	227	19	50	19	6
Cork	256	245	24	50	28	3
Dublin	278	268	22	38	33	7

The table shows that the orang-type occurs in from 38 to 51 per cent. of women, while in men it varies between 16 and 27 per cent. Taking the average of this table, the orang-type may be said to occur in 18 per cent. of men and 45 per cent. of women. The chimpanzee-type, on the other hand, occurs four or five times more frequently in men than in women. That the orang-type should be characteristic of women and the chimpanzee of men is what one may expect; for in bodily characters, always excepting those of a sexual nature, woman apparently foreshadows the coming characters of the race.

My statistics are not sufficiently wide to allow of more than a partial statement as to the orang-type of ear being a sign of aristocratic birth, but of eight peeresses I find five have ears of this type, which certainly lends some support to the popular supposition. On the other hand, of five leading lady singers only one shows this type of ear.

Race, too, has an influence on the proportion with which the two types occur. That may be seen from Table I. The prevalence of the chimpanzee-type in Kerry, and the orang-type amongst the Jewish women may be noted. The orang-type occurs in about 90 per cent. of Hottentots; it is very frequent, although of a characteristic type, in certain races of negroes.

The ear-types, too, are correlated with the colour of the hair. In Table II. statistics are given of observations made at twenty-seven different localities of the United Kingdom.

TABLE II.

	No. of Observations. Male.	Female.	Orang-type. Male. Per cent.	Female. Per cent.	Chimpanzee-type. Male. Per cent.	Female. Per cent.
Fair-haired	2015	1127	31·3	46·7	15·8	4·1
Black-haired	1796	1463	15·8	40·3	36	4·7

The individuals with hair of intermediate shades of brown are omitted, and only those with distinctly fair or distinctly black hair are included. It will be seen that the orang-type occurs in fair-haired men twice as frequently as in black-haired men; the chimpanzee-type occurs in exactly the reverse proportion. Curiously enough the colour of hair scarcely affects the ear of the woman; black and fair show both types with an equal frequency. Both this table and the last draw attention to the fact that the variations in one sex are not necessarily correlated with those of the other.

It will be readily seen how necessary it is to consider those various factors which influence the ear before proceeding to consider the ears of those who have their liberty temporarily or permanently suspended because they are no longer able to conform to recognised social standards of conduct. The variation according to race or locality is wide (*vide* Table I.); sex and other qualities are influencing factors. In the following table (Table III.) are given the proportions with which the orang- and chimpanzee-types of ear occur (1) in habitual criminals, obtained through the courtesy of Dr. Garson; (2) the insane of four asylums in different parts of the kingdom; (3) congenital idiots.

TABLE III.

Locality.	No. of observations. Male.	Female.	Orang-type. Male. Per cent.	Female.	Chimpanzee-type. Male. Per cent.	Female.
Scotland Yard	326	208	35	33	15	12
Aberdeen Asylum	190	211	23	40	16	8
Durham Asylum	211	208	26	40	18	3
Cork Asylum	202	205	12	37	19	3
Dublin Asylum (Richmond)	189	204	29	33	12	3
Congenital idiots	27	9	26	66	4	0

Taking the insane first, it will be observed (compare Tables I. and III.) that on the whole the insane, so far as relates to the prevalence of the two types of ears, do not show a marked deviation from the sane of their neighbourhood and that there is no constant difference between the two classes. The insane men of Aberdeen and Cork show the orang-type less frequently than the sane; in Dublin the case is the reverse. In the insane women a similar variation is shown in the prevalence of this type; in one case it is lower, in another higher and in still another the same. It is so also as regards the chimpanzee-type. We must, therefore, conclude, so far as concerns these two types of ears, that there is no correlation between them and a bias towards insanity.

The congenital idiots show a prevalence of the orang-type, considerably above the average, and an occurrence of the chimpanzee-type below the average, but the number of the observations is too small to allow of any certain conclusion.

When, however, the confirmed criminal class is dealt with a striking departure from the normal is encountered—quite unlike the statistics gained from any other series of observations. The sexual ratio becomes inverted; the orang-type, instead of occurring in the female twice as frequently as in the male, which is the normal ratio in the sane, occurs with the greatest frequency in the male. So, too, with the chimpanzee-type, it is found almost as frequently in the female as in the male. In short, male criminals show a preponderance of the orang-type, female criminals of the chimpanzee-type. There is a reversion of the normal sexual ratio.

Thus it will be seen that, taken as a *class*, not as individuals, criminals show a departure from the sane in their physical constitution. But what does this really mean? It means, I take it, that the criminal class is recruited in undue proportion from the group of men who manifest the orang-type of ear and the women who possess the chimpanzee-type. A larger proportion of individuals of these two classes is predisposed towards crime than those with opposite types. But clearly the presence of the orang-type of ear in any individual is of itself no evidence of this predisposition.

I have already shown that the ratio in which these two types of ear occur is correlated with the colour of the hair. On comparing the colour of the hair of the criminal class with that of groups of people in various parts of the country, for the criminals I dealt with were drawn from almost every county, I found that the criminal class was drawn in an undue proportion from the black-haired men, in a lesser degree, also, from the black-haired women, and that therefore the orang-type should occur in them with a decreased, and not as it does with an increased, frequency.

Darwin's Point.—Since Darwin drew attention to the remnant of the tip of the human ear, an enormous literature has grown up around it. Vali found that it occurred with thrice the normal frequency in the insane; but before considering the relationship which its presence bears to an unstable mental equilibrium it is necessary to clear away some popular misconceptions that still prevail as to its nature.

It is not the case, as the following table (Table IV.) will show, that it is only in the human ear that the tip has become lost; it will be seen that this is also the case in all the anthropoids, a group that is genetically closely related to man. In all

TABLE IV.—*The Occurrence of Darwin's Point.*

(1) In Apes and Anthropoids.

	No. observed.	Present.
Baboons	15	100 per cent.
Macaques	21	95 ,,
Cercopitheques	19	80 ,,
Semnopitheques	29	45 ,,
Gibbons	12	0 ,,
Orangs	15	40 ,,
Chimpanzees	23	9 ,,
Gorillas	19	26 ,,

(2) Races of Men.

	No. of observations. Male.	Female.	Present. Male. Per cent.	Female.
African Negroes	29	—	7	—
Hottentots	18	—	6	—
Andamanese	52	15	38	40
Turin (Gradenigo)	—	—	3·5	3
English (Peterborough)	306	247	12	4
Lower Alsace (Schwalbe)	—	—	36	11
Upper Alsace (Schwalbe)	—	—	21	14
Kerry	282	209	13	9
Dublin	267	268	12	10
Cork	254	254	14	7

the anthropoids the tip occasionally recurs, showing that they come of a stock in which the ear was tipped. Only two groups of the old-world monkeys constantly retain the tipped form of ear—these are the macaques and baboons; in the other three groups of old-world monkeys (see Table IV.) the tip has already begun to disappear. It is probable, then, that the tipped form of ear began to disappear during an early stage in the evolution of the anthropoid and human stocks.

There can be little doubt that in the ear of the baboon or macaque (see Fig. 6) we have preserved for us approximately the form out of which the different types of ear seen in the higher Primates, including man, have been evolved. The tip occurs at the junction of the horizontal and descending helix; in this position it has to be looked for in man.

The complete or partial disappearance of the tip of the ear is part and parcel of the retrogression of the descending helix. When the descending helix (posterior border) becomes inrolled, then the tip is also inrolled. In the third month of fœtal life, the descending helix is not yet inrolled and the tip is constantly present on the human ear (Schæffer). Some trace or indication of the tip can be made out in 75 per cent. of adult men (Schwalbe). But in the statistics I give here relating to this structure, only those cases are included which showed Darwin's point in an unmistakable and pronounced form.

It is clearly evident from Table IV. that, before any deduction as to the presence of this structure on the ears of the criminal and insane classes can be made, the influence of race and sex must be taken into account. It is more frequently present in the male than the female; Schwalbe found it three times more so in the males of Upper Alsace, and this agrees with what I found in a typical English place, such as Peterborough.

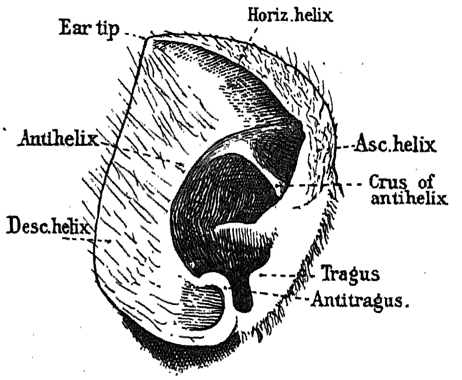


FIG. 6.—Ear of Macaque.

In the African negro it is rarely present; the helix of his ear has undergone so marked retrogressive changes; but in the Andamanese it is frequently present—more so in the women than men. The ratio of its presence varies widely with the race and locality.

In Table V. are given the results of observations made on (1) the insane, (2) criminals, (3) congenital idiots.

TABLE V.—*The Occurrence of Darwin's Tip in the Insane, in Criminals and in Congenital Idiots.*

Place.	No. of Observations. Male.	Female.	Present. Male. Per cent.	Female. Per cent.
Aberdeen Asylum[1]	198	209	13	15
Durham Asylum	211	206	22	19
Cork Asylum	203	205	23	20
Dublin Asylum	189	203	26	18
Scotland Yard	328	201	27	17
Congenital Idiots	27	—	37	—

Unfortunately I have no "control" observations on the population from which the insane of Aberdeen and Durham are drawn, but in the case of Cork and Dublin I have, and it is seen that Darwin's point comes out in the insane with double the frequency, or rather more, than that with which it occurs in the sane. The criminals also show it with a much greater frequency than I have found in any locality throughout the country. Its frequency is especially marked in congenital idiots and those vagabonds that congregate at the doors of the police courts and night shelters in London and Liverpool.

[1] I am greatly indebted to the superintendents of these four asylums for the opportunities and help they afforded me.

Darwin's point, the structure which we now deal with, differs very materially in nature from the subject last considered, viz., the type of ear. The two types of ear were symptoms merely of progressive or retrogressive development, but Darwin's point is the persistence of an ancestral or, what amounts to nearly the same thing, a fœtal form, and with this persistence might be expected a correlated persistence, to some extent at least, of the ancestral faculties of the brain. This certainly does not hold true of the individual; it does to some extent of the mass. Clearly the insane and criminal classes are drawn with an undue proportion from those in which Darwin's point is pronouncedly present.

The Lobule.—Before concluding, I wish briefly to refer to this structure, because it differs in nature from the two features of the ear already considered. It is a structure of comparatively recent addition to the ear. It is not the case that it is a feature peculiar to man; it may be detected, as Table VI. shows, in the ears of the three great anthropoids, but it is only in man that it finds a full and almost constant development, and therefore may be regarded as a recently added and progressive structure.

TABLE VI.—*The Development of the Lobule in Anthropoids and Races of Men.*

	Number of observations. Male.	Female.	Index of development. Male.	Female.
Orangs	13	both sexes	·25	
Chimpanzees	23	"	·3	
Gorillas	19	"	1·	
Negroes	29		1·1	
Andamanese	52	16	1·3	1·5
Aberdeen	473	563	1·5	1·7
Peterborough	182	140	1·3	1·3
London, E.	684	383	1·4	1·5
Jews	119	83	1·7	1·9
Hamburg	252	164	1·3	1·5
Cork	254	254	1·7	1·8
Dublin	264	285	1·7	1·9
Aberdeen Asylum	211	208	1·4	1·5
Durham Asylum	211	206	1·5	1·6
Cork Asylum	202	205	1·8	1·8
Dublin Asylum	189	203	1·5	1·6
Scotland Yard	330	201	1·5	1·7
Congenital idiots	27	9	1·2	1

It is necessary to allude to the manner in which the index of the development or size of the lobule was obtained. A reference to Fig. 5 will assist in the explanation. I became accustomed to measure with the eye the various degrees to which the lobule was developed and arranged them in four groups:—(1) those in which the lobule was extremely small or absent; (2) those in which it was developed to the first degree; (3) those in which it was developed to the second degree; and (4) those of the largest or third degree. Those degrees are indicated in Fig. 5. An index of 1·6, for instance, signifies that the average lobule in that group of individuals reached, in my artificial standard, 1·6 degrees of development. The method is not accurate; nothing less than actual measurements would render it so; but before such a laborious process is undertaken one requires to be assured that some very definite result will be accomplished. My method is accurate enough for the purposes of comparison and for eliciting any decided factor which may be at work.

It will be seen that it is the case with the lobule as with the two other features of the ear, that its development varies with sex and race. It is larger in the female than in the male; it is larger in the white races than in the black.

Its development in the insane and criminal classes does not depart to any marked extent from that of the normal classes. In the insane of Aberdeen and Dublin, the lobule was smaller than that of the sane of the same localities, but in Cork the difference was rather the reverse. It appears to reach an average development in criminals, but in congenital idiots, on the other hand, it rather approaches the degree of development met with in the gorilla.

To sum up. This investigation was originally undertaken to see how far the characters of the external ear might

be utilised in unravelling the genetic connection of human races; it was only incidentally, when I became aware of the extraordinary degree of individual variation, that I was drawn into the investigation of features which have been described as "marks of degeneration." The result of my inquiries in this direction has been to show that only two out of the seven features of the external ear which I investigated are correlated with a mental bias towards crime or insanity, viz. a retrograde development of the helix and a persistence of the ear tip.

My results are the more valuable because I was at first sceptical of the very definite results obtained by continental observers on the insane and criminal classes. It appeared very probable that the definiteness of their conclusions would disappear if allowances were made for the populations from which the criminals and insane were drawn and for the influence of race, sex and colour. After making those allowances, however, there remain a certain number of characters peculiar to these classes, of which those I have cited in the ear are only examples. But, unfortunately for any practical application of Lombrosa's doctrine to the detection of the socially unfit, the physical differences between the sane and the insane or criminal classes are those of degree or ratio, not of kind. The characters may assist in the detection of the class, but not of the individual.

All that can be deduced from the present investigation is that a slightly greater proportion of the people who have ear tips and retrograde helices give themselves over to crime than those in which these two features are absent. The evidence is just sufficient to justify the suspicion that a small proportion of criminals are criminals because of their physical constitution, and it is certainly the duty of every anatomist to discover how such individuals may be recognised. As yet all the criminal marks we know of can only be stated in relative terms of the class, and have, unfortunately, no application to the individual.

ARTHUR KEITH.

SCHOOL BOARD EXHIBITION OF SCIENTIFIC APPARATUS.

ONE of the reasons often given as an excuse for not introducing instruction in the elementary principles of science into the curriculum of elementary schools is the expense involved in providing the necessary apparatus for experimental demonstrations. It is common to find that school managers have very exaggerated ideas as to the amount of really necessary equipment. Though it has been the custom for some years, at institutions like the Royal College of Science, to instruct the students in training to become science teachers how effective apparatus can be made at a very small cost and with a minimum of mechanical dexterity, the great majority of science teachers, notably those of elementary schools, have had few opportunities of acquainting themselves with the use that may be made of the odds and ends of domestic life to construct instruments which can be effectively used in simple work in experimental science.

The School Board for London has recently taken steps to remedy this defect in the training of its teachers. Influenced by the heavy expenditure on apparatus to which it has been put, and convinced that the construction of simple instruments can be made a valuable assistance in teaching science, the Board has for some months encouraged its teachers to make apparatus themselves and to give their pupils opportunities of making models to illustrate the principles of the lessons they have received. The exhibition at the Examination Hall on the Embankment (see NATURE, p. 656) represents the results of these efforts up to the present time. Though satisfactory if considered as the first exhibition and as showing that an earnest attempt is being made to give science its proper place in training children for the business of life, there are some directions in which improvement is easily possible. It must be understood that in pointing these out we do not lose sight of the difficulties the organising committee has had to overcome, but desire simply to suggest what may be done to ensure a better set of exhibits next year.

In the present exhibition the work of teachers, adult students in evening classes and children in day schools are indiscriminately mixed up. The work of comparison is consequently very difficult, and it is to be feared that the boys and girls will be a little disheartened to find their work side by side with that of their instructors and their big brothers in the continuation school. Nor is it easy to form an idea of the work of the pupils of different schools. It is only after consulting a catalogue, or reading a label affixed to the exhibit, that the visitor is able to find the school from which the maker of the apparatus comes. It would be better in the future to have together typical sets of apparatus from different schools.

It is difficult to estimate the relative importance given to different branches of science by the Board. There is a large number of exhibits in statical electricity, but only two pieces of apparatus shown in connection with the study of light and three to illustrate the teaching of physiography. The subjects of heat and voltaic electricity are, judging from the number of exhibits, popular, while acoustics meets with very scant recognition. It is disappointing, too, to find so little attention given to Nature-knowledge. From the conditions of city life it is hard for children to get even a nodding acquaintance with the beauties of organic life, whether animal or vegetable, and the school should be able to help the youngsters to learn something of the joys of country life. So much has been accomplished in recent years in the direction of providing simple school museums of common botanical and zoological objects, that it is to be hoped the teachers and scholars will be encouraged to do something in this direction. Then, why is nothing done to familiarise the children with the "starry heavens"? We looked in vain for a simple home-made telescope. Yet teachers have been shown for many years past in the astrophysical laboratory at South Kensington how a really effective instrument can be made with cardboard tubes at a trifling expenditure.

But a good beginning has been made. If more attention is in the future given to some of the subjects we have indicated, and if the work of teachers is separated from that of the taught, the utility of the exhibition will be much enhanced.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

CAMBRIDGE.—An election to the Isaac Newton Studentship in Physical Astronomy and Optics will be held next term. Candidates must be Bachelors of Arts under twenty-five on the first day of 1902. The studentship is of the value of 200*l*., tenable for three years. Applications are to be sent to the vice-chancellor between January 16 and 26.

On November 4, Mr. R. P. Paranjpye, the Indian student who was bracketed senior wrangler in 1899, was elected to a fellowship at St. John's College.

PROF. WILLIAM RAMSAY, F.R.S., commenced a course of twelve lectures on "The Recent Developments of Chemical Theory" at University College, London, on Friday last. This course is especially designed for those who have a previous acquaintance with inorganic and organic chemistry and who may wish to know the present standpoint of chemical thought.

AT the annual meeting of the governors of Dundee University College last week Mr. John Morley referred to the signs of increasing interest in universities and the increasing force which must be given to the movement in order to put ourselves in the position of other progressive nations. He hoped that the movement had not yet attained full flood, because "all those who inquired into the conditions of scientific training in Germany and the United States were really—he was not using an excessive word—dismayed when they found the comparative shabbiness and meagreness of the buildings, funds and equipments in this island. There was no form of care for the public weal more distinctly certain of being reproductive than that care which placed within the reach of the coming generation opportunities for making the best of itself and giving to the Commonwealth the best of its faculties. That was now a commonplace. The immediate question was, what was to be done in order to raise Dundee and other places in Scotland up to the level which public necessities—national necessities—Imperial necessities if they liked—demanded?" The answer is—and it will serve for practically all institutions for higher education in the British Isles—Increase the teaching resources by building and equipping laboratories, encourage original work rather than the multiplication of successes in examinations, create in the public mind a spirit of sympathy with scientific work, and inspire the Government to action before it is too late.

A SCHEME for the extension and better equipment of the University of Glasgow, especially in the departments of

medical and physical science, was approved at an influential meeting of members and friends of the University held in the Glasgow City Chambers last week. Addressing the meeting, Principal Story said that in the beginning of the present year an executive committee was formed to provide funds for carrying out the measures of extension and reform considered of primary importance, and already they had received a sum of more than 62,000*l.*, including 10,000*l.* given for a special lectureship. It was proposed to make good the defects by the erection of additional premises for the class rooms, departmental museums, and laboratories of physiology, materia medica and forensic medicine, and public health. The needs of the chemical department, which could be regarded as belonging both to the faculty of science and to that of medicine, might be met, but only partially and temporarily, by the transference of premises available when physiology was provided for. A set of thoroughly furnished chemical laboratories is one of the most immediate wants, and additional accommodation is needed by the department of physical science. The full realisation of these designs must necessarily be a work of time, and will cost in all probably not far short of 100,000*l.* But it is encouraging to know that within the last few months more than the half of this sum has been subscribed. For the other half the University must depend upon the generosity of its many friends.

SCIENTIFIC SERIALS.

American Journal of Science, October.—On galvanometers of high sensibility, by C. E. Mendenhall and C. W. Waidner. A description of the design and manufacture of a delicate galvanometer of the four-coil Thomson type. There is a detailed discussion of the methods for obtaining the highest sensibility and also of the causes of the changes of zero.—On a method of locating nodes and loops of sound in the open air, with applications, by Bergen Davis. A small mill-like arrangement, constructed by placing four hollow cylinders of gelatine at the end of cardboard arms in such a manner that the closed ends pointed in the same angular direction, was mounted in the mouth of a resonator with the plane of the system perpendicular to the mouth. The resonator was in unison with an organ pipe, and when the pipe was blown the mill was found to rotate with a high velocity, the position of the nodes and loops being readily determined with considerable accuracy. In the open air the effect could be observed up to about sixty feet from the pipe.—The anatomy of the fruit of *Cocos Nucifera*, by A. L. Winton.—Studies of Eocene mammalia in the Marsh collection, Peabody Museum, by J. L. Wortman.—A new crinoid from the Hamilton of Charlestown, Indiana, by E. Wood.—On the estimation of cæsium and rubidium as the acid sulphates, and of potassium and sodium as the pyrosulphates, by P. E. Browning.—Time values of provincial carboniferous terranes, by C. E. Keyes.—The spectra of hydrogen and some of its compounds, by John Trowbridge. The vacuum tubes used in the experiments described were illuminated by a current derived from a large battery of storage cells and not from a Ruhmkorf coil. The conclusions drawn from these investigations, which are at variance with the views generally received, are that hydrogen is an insulator, the passage of electricity through hydrogen, oxygen, nitrogen and their gaseous compounds being conditioned by the water vapour present. Certain carbon bands are always present in glass tubes filled with hydrogen, nitrogen, oxygen and ammonia gas, notwithstanding the greatest care taken during filling. The X-rays excited by the application of a steady current are due to the radiations set up by the dissociation of highly rarefied water vapour.

Bulletin of the American Mathematical Society, October.—Prof. F. N. Cole gives an account of the proceedings at the eighth summer meeting of the Society, held at Cornell University, Ithaca, New York, August 19–24. It was a largely attended meeting, and various circumstances made an adequate provision of time for the reading and discussion of the thirty-two papers presented practically impossible. The titles and abstracts occupy more than twenty pages. The third colloquium of the same Society was also held on the same date. Dr. Kasner gives an abstract of the proceedings at the two previous colloquia, as well as of this one. During the four days, two courses of four lectures each were delivered by Prof. Oskar Bolza, on the simplest type of problems in the calculus of variations, and by Prof. E. W. Brown, on modern methods of treating dynamical problems, and in particular the problem of three bodies. Grateful acknowledgments were made of the hospitality of the University and for the numerous privileges which were afforded to the members present. Short notices are given of two of the papers: upon the non-isomorphism of two simple groups of order 8!/2, by Miss Schottenfels, and concerning surfaces whose first and second fundamental forms are the second and first fundamental forms respectively of another surface, by Prof. A. Pell. Extensive notes of the mathematical courses for the session 1901–1902 at several Universities follow, with other matters of personal interest. Several pages are also devoted to new publications.

SOCIETIES AND ACADEMIES.

LONDON.

Entomological Society, October 2.—The Rev. Canon W. W. Fowler, president, in the chair.—Mr. G. C. Champion exhibited a long series of *Buprestis sanguinea*, Fabr., from Albarracin, Spain, showing the remarkable dimorphism of this species.—Mr. H. St. J. Donisthorpe exhibited on behalf of the Rev. H. S. Gorham, of Shirley Warren, a specimen of the scarce beetle, *Hister marginatus*. He also exhibited a number of rare Coleoptera from the New Forest, including *Velleius dilatatus*, F., from hornets' nests, *Anthaxia nitidula*, L., *Agrilus sinuatus*, Ol.—not taken for many years—*Agrilis viridis*, L., *Platydema violaceum*, F., a species also not recorded recently, and *Collydium elongatum*, F., one specimen taken in the burrows of *Melasis buprestoides* and another in the burrows of *Scolytus intricatus*. Mr. Champion said that Mr. George Lewis associated *Velleius* with *Cossus* and not with hornets.—Mr. C. P. Pickett exhibited varieties and aberrations of *Lycaena corydon* taken during August at Dover, and a series of *Angerona prunaria* (bred June and July), the results of four years' interbreeding, showing a wide range of coloration.—Prof. T. Hudson Beare exhibited a specimen of *Medon castaneus*, Grav., taken at the edge of a pond in Richmond Park.—Mr. A. Harrison exhibited a series of *Amphidasys betularia* bred from parents taken in the New Forest in 1900, including six gynandromorphous specimens.—Mr. C. J. Gahan exhibited a male specimen of *Thamnotrizon cinereus*, L., one of the long-horned grasshoppers taken by Mr. F. W. Terry at Morden, near Wimbledon, and called attention to a very interesting abnormality displayed by the specimen in possessing two pairs of auditory organs instead of a single pair, the second pair being situated on the tibiæ of the middle legs in a position corresponding with that of the normal pair on the fore-legs.—Mr. F. Merrifield exhibited a series of *O. antiqua* much darker than the type, bred from pupæ placed in a refrigerator five weeks and then exposed to a mean temperature of 48° F.—Mr. R. South communicated a paper by the late Mr. J. H. Leech, entitled "Lepidoptera-heterocera from China, Japan and Corea (Pyralidæ)"; Mr. G. C. Champion contributed notes and observations upon the sexual dimorphism of *Buprestis sanguinea.*

October 16.—Mr. E. Saunders, vice-president, in the chair.—Mr. C. Morley exhibited for the Rev. E. N. Bloomfield leaves of hornbeam from Battle, and a photograph of leaves of sweet chestnut from Haslemere, rolled by *Atelabus circulionoides.*—Mr. R. Adkin exhibited a specimen of *Pieris daplidice* taken by him at Eastbourne on August 19 last. He said that the insect was flying strongly, and in that respect and indeed in general appearance resembled on the wing a pale female of *Colias hyale.*—Mr. C. P. Pickett exhibited series of *Melitaea cinxia* bred in June last from larvæ taken in the Isle of Wight, including light and dark varieties, and a series of *Choerocampa elpenor* bred in June last from larvæ taken at Broxbourne in July 1900, including a variety of the male with purplish lower wings and another with purple markings on the upper wings.—The Rev. F. D. Morice exhibited specimens of *Hedychrum rutilans*, Dhl., and *Salius propinquus*, Lep., taken at Lyndhurst by Miss Ethel Chawner, and both new to the British list. He also exhibited two monstrosities, viz. *Allantus arcuatus*; (sawfly) with two perfect wings, and two other imperfectly developed wings on the left side, and *Gorytes quinquecinctus* (fossor) with the abdominal segments extraordinarily twisted out of their proper shape and places.—Mr. Arthur M. Lea communicated a list of the Australian and Tasmanian Mordellidæ, with descriptions of new species; and Mr.

Edward Meyrick, descriptions of new Lepidoptera from New Zealand.—Mr. E. Saunders then read a paper upon Hymenoptera aculeata collected in Algeria by the Rev. E. A. Eaton and the Rev. F. D. Morice, part i., Heterogynæ and Fossores to the end of Pompilidæ.

Royal Microscopical Society, October 16.—Mr. Wm. Carruthers, F.R.S., president, in the chair.—Messrs. C. Baker exhibited a portable microscope on the model of the "Diagnostic," originally designed for Major Ronald Ross's investigations of malaria. It is made of magnalium, an alloy of manganese and aluminium, and weighs but fourteen ounces. This firm also exhibited a microscope intended for the examination of fractures and etched surfaces of metals. The instrument is provided with vertical illuminator, and rack and pinion focussing adjustment and levelling screws to the mechanical stage, now usual in this class of instrument.—Messrs. R. and J. Beck exhibited a portable model of their "London" microscope, which, by the introduction of several ingenious devices, could be packed with the apparatus into a leather case $2\frac{1}{4}$ inches × $4\frac{1}{2}$ inches × $9\frac{1}{2}$ inches. Messrs. Beck also exhibited a centrifuge, made to run at a high speed by an electric current.—The president showed some specimens of the mycetozoa and gave a brief account of the life-history of this group of organisms. The specimens belonged to a recently described species and had been named *Badhamia foliicola*. He directed attention to the exhibits by Mr. C. L. Curties consisting of a number of mounted specimens of marine zoological objects, accompanied by very full and interesting descriptions.—The president gave a *résumé* of a paper, by Miss A. Lorrain Smith, on fungi found on germinating farm seeds. Miss Smith had been assisting him in his work for the Royal Agricultural Society in examining farm seeds in respect to their germinating power. In the course of their observations Miss Smith had found numerous species of fungi on the germinating seeds, fourteen species in all, of which five were new and one belonged to a new genus.—The secretary announced the receipt of part xiv. of Mr. Millett's report on the foraminifera of the Malay Archipelago, which was taken as read.

Manchester.

Literary and Philosophical Society, October 15.—Mr. Charles Bailey, president, in the chair.—Mr. R. L. Taylor remarked that he had noticed that the Manchester water appeared to contain an unusual amount of dissolved chlorides at the present time, and, on roughly estimating the amount of dissolved solids, found that the total had, curiously enough, gone up from a normal amount of about $4\frac{1}{2}$ grains to about $9\frac{1}{2}$ grains per gallon, due, no doubt, to the recent scarcity of water and to the concentration by evaporation on the gathering grounds and in the reservoirs.—Mr. R. D. Darbishire exhibited a large collection of the Eolithic implements of the Kentish plateau, and illustrated with map and section the outline of the denudation of the valley of the Weald, leaving a drift deposit on the remaining chalk of the north and south encarpments. In the process many levels of river gravels had been fixed, and partly occupied by stone implements of successive ages, mostly much mixed up in the redisposition of the gravels by succeeding movements. He described the general facies of the so-called Palæolithic implements from river deposits in France and England and their peculiar modes of manufacture by "chipping" or flaking, and shapes; and confessed inability to determine the uses of such tools or any characteristics of the men who made them. They were fossil indications of man with mind, skill, and purpose, and that was all.

October 29.—Mr. Charles Bailey, president, in the chair.—Dr. C. H. Lees was elected to the office of honorary secretary in succession to Prof. A. W. Flux.—Mr. C. E. Stromeyer read a paper on explosions of steam-pipes due to water-hammers, dealing with the subject both from a theoretical and practical point of view. He referred to the reports of the Commissioners of the Board of Trade, according to which about fifty steam-pipe explosions have occurred from the above causes during the last seventeen years, and said that the majority were brought about by the opening of drain-cocks of steam-pipes in which water had accumulated, while a few were clearly due to a plug of water having been shot from the boiler ends of the pipes to the engine-ends. Mr. Stromeyer first investigated the pressure which is set up when an elastic body suddenly comes to rest, the solution of which problem was correctly guessed at by Dr. A. Ritter in 1889, but he was unable to give a proof of the possibility of discontinuity of motion, which is part of the phenomena of an elastic blow. This point was illustrated by means of an unloaded helical spring. Having established this theory, it follows that when an elastic prismatic body is moving axially its front surface comes to rest instantaneously on contact with an unmovable obstacle, while the more distant parts of the bar come to rest also instantaneously when the wave of pressure or of change of velocity reaches them. This wave travels with the velocity of sound, and as the tail end of the bar has maintained its velocity, the axial pressure in the bar is the product of the elasticity of the material into the ratio of the velocity of the object to the velocity of sound. With the help of this theory it is easy to calculate the pressure which a plug of water of a given length travelling a given distance under the influence of a given pressure will exert if brought to a full stop.—A paper entitled "A Preliminary Note on the Preparation of Barium" was read by Mr. Edgar Stansfield. Results were given of a critical study of hitherto proposed methods of preparing metallic barium. The most promising results were obtained by the Goldschmidt process, by which alloys of barium and aluminium containing up to 60 per cent. of barium were produced, when the experiment was carried out *in vacuo* to avoid the formation of oxides and nitrides.

Paris.

Academy of Sciences, October 28.—M. Bouquet de la Grye in the chair.—Experiments on some chemical reactions determined by radium, by M. Berthelot. A comparison of the action of light and of the radium rays in promoting certain chemical reactions. The reactions used were the decomposition of iodic acid, of anhydrous nitric acid, the oxidation of oxalic acid, and the polymerisation of acetylene. In the first two cases the action of the radium rays was exactly similar to that of light, except that the action was much feebler; in the two latter experiments no action was observed. It is suggested as possible that the glass vessels, in which the radium salts were necessarily enclosed, may have cut off that portion of the rays which is capable of the most energetic effects.—On the heat disengaged in the reaction between free oxygen and potassium pyrogallate, by M. Berthelot.—On a prehistoric lamp found in the cave of La Mouthe, by M. Berthelot. An examination of the carbonaceous substance scraped off a prehistoric lamp found by M. Em. Rivière showed that these residues are similar to those which would be left after combustion of a fatty material of animal origin, badly separated from its membranous envelopes.—The junction of a closed network of trigonometrical triangles, by M. P. Hatt. An application of the method of least squares to the method previously developed.—On the flagella of the undulating membrane of fishes (*Trypanosoma*), by MM. A. Laveran and F. Mesnil. The existence of organisms with undulating membrane and with two flagella would appear to be doubtful, and the authors regard the creation of a new genus for these organisms as necessary, and propose the name *Trypanoplasma*.—On Foucault's top, by M. A. S. Chessin.—On the stability of commutators, by M. Maurice Leblanc. A discussion of the cause of irregularity in the motion of a commutator in connection with a number of accumulators, and of the methods of overcoming this.—The minimum value of the total heat of combination, by M. de Forcrand. By an expansion of a formula given in a previous paper the minimum value of the total heat of combination can be calculated. This has been done for a considerable number of substances, and these compared with experimental data as far as available.—A contribution to the study of the copper-aluminium alloys, by M. Leon Guillet. The alloys were obtained by heating aluminium with pure oxide of copper. By the application of this method, which had previously given successful results with molybdic and tungstic acids, three compounds could be isolated, Cu_3Al, $CuAl$ and Al_2Cu. These had been already prepared by a different method by M. Chatelier.—On the separation of iron, by M. Paul Nicolardot. Ferric chloride, after being heated to 125° C. for some hours, forms an insoluble sulphate on adding ammonium sulphate to its aqueous solution. No other metals likely to be present in iron or steel are precipitated. The analysis of certain special alloys is rendered very simple by this method.—The qualitative and quantitative determination of traces of antimony in the presence of large proportions of arsenic, by M. G. Denigès. Two methods are suggested, the first depending upon the separation of the antimony by metallic

tin in a platinum dish, and the second upon the formation of a double salt with cæsium iodide, and examination under the microscope of the crystalline deposit.—Researches in plants on cane sugar with the aid of invertin and of glucosides with the aid of emulsin, by M. Ed. Bourquelot.—On the estimation of the alkalinity of the blood, by MM. August Lumière, Louis Lumière and Henri Barbier. After a comparison of the results obtained by various methods that have been suggested the authors adopt an iodometric method, the results given in this way being regarded as much more exact than those obtained in the usual way.—The liberoligneous bundles of ferns. The union and separation of the liberoligneous elements, and some consequences, by MM. C. Eg. Bertrand and F. Cornaille.—On two states of the living substance, by M. Felix Le Dantec.—Remarks concerning the formation and origin of fine pearls, by M. L. G. Seurat. A criticism of the theory put forward by M. R. Dubois.—The nematod of the beet-root (*Heterodera Schactii*), by M. Willot.—On the mode of production of divergent luminous rays at 180° from the sun, by M. G. Sagnac.

NEW SOUTH WALES.

Royal Society, September 4.—Mr. H. C. Russell, F.R.S., president, in the chair.—Recurrence of rain—the relation between the moon's motion in declination and the quantity of rain in New South Wales, by H. C. Russell, F.R.S. The paper was essentially a continuation of that on the periodicity of good and bad seasons, read June 3, 1896. The author stated that while coastal rains were irregular, those of the interior showed a 19-year periodicity. Regretting that observations did not extend over a more lengthy period, it was pointed out that some rain records of Horsham, Victoria, dating back to 1848 were valuable, our first record at Bathurst beginning in 1858. To minimise possible errors, the averages of neighbouring stations were taken. An illustrative diagram accompanied the paper, the author stating that between 1850 and 1851, 1869 and 1870, and 1888 and 1889, the thick vertical lines—nineteen years apart—divided the records in "natural spaces" in which the first six years had abundance of rain, and the remainder was a "dry period." The first bad year of the series we were stated to be now in was 1895, the loss of sheep from starvation between 1895 and 1900 being alleged to be 25,000,000, not including the loss of 20,000,000 natural increase. The diagram showed also the curve of extreme southerly declination of the moon for each year. The author, in conclusion, stated that rain is shown for three periods of nearly nineteen years each, "to come in times of abundance when the moon is in certain degrees of her motion south, and when the moon begins to go north, the droughty conditions prevail for seven or eight years," which he says is "either a marvellous coincidence, or it is a law connecting the two phenomena," and he is convinced that there is some connection between the two.—The theory of city design, by G. H. Knibbs. The subject was systematically treated under the following headings: (1) introductory; (2) general idea of a city; (3) radial street-system; (4) position of radial centres; (5) combination of radial and rectangular street-systems; (6) curved streets; (7) cardinal direction of rectangular streets; (8) width of streets; (9) localisation of the various types of street; (10) grade and cross-section of streets; (11) engineering features of streets; (12) size of blocks between streets; (13) height of buildings; (14) theory of aspect; (15) the æsthetics of design; (16) sites for monumental buildings and monuments; (17) treatment of street; from the standpoint of æsthetics; (18) public parks and gardens; (19) hygienic elements of design; (20) the preliminaries of design; (21) conclusion.

DIARY OF SOCIETIES.

THURSDAY, NOVEMBER 7.

LINNEAN SOCIETY, at 8.—On the Life-history of the Black-currant Mite (*Phytoptus ribis*): Mr. Warburton and Miss Embleton.—Notes on the types of Species of *Carex* in Boott's Herbarium: C. B. Clarke, F.R.S.

RÖNTGEN SOCIETY, at 8.30.—Presidential Address: Herbert Jackson.

CHEMICAL SOCIETY, at 8.—Note on the Non-existence of a Higher Oxide of Hydrogen than the Di-oxide: Prof. W. Ramsay, F.R.S.—The Electrolytic Reduction of Nitrourea: G. W. F. Holroyd.—(1) The Constitution of Pilocarpine, III.; (2) A New Synthesis of α-Ethyl Tricarballylic Acid: H. A. D. Jowett.—The Action of Nitric Acid on Methyl Dimethylacetoacetate: Prof. W. H. Perkin, F.R.S.—(1) An Incrustation from the Stone Gallery of St. Paul's Cathedral; (2) Note on Asbestos: E. G. Clayton.—Liquid Nitrogen Peroxide as a Solvent: Prof. P. F. Frankland, F.R.S., and R. C. Farmer.

FRIDAY NOVEMBER 8.

ROYAL ASTRONOMICAL SOCIETY, at 5.—Recent Observations of the Position of Nova Aurigæ, made with the 40-inch Telescope of the Yerkes Observatory: Prof. E. E. Barnard.—The Determination of Selenographic Positions and the Measurement of Lunar Photographs, II.: S. A. Saunder.—Ephemeris for Physical Observations of the Moon for 1902: A. C. D. Crommelin.—A New Method of Interpolation: T. C. Hudson.—On Periodic Orbits in the Neighbourhood of Centres of Libration: H. C. Plummer.—The Spectrum of Nova Persei from February 28 to April 26, 1901: Rev. W. Sidgreaves.—Ephemeris for Physical Observations of Jupiter, 1902–3: A. C. D. Crommelin.—On the Variation of T Centauri: A. W. Roberts.—Comparison of the Geocentric Places of Uranus, Neptune and the Sun, calculated from Newcomb's Tables, with their Places calculated from Le Verrier's Tables, for 1904: Dr. A. M. W. Downing.—On the Abnormal Photographic Image of Nova Persei: E. M. Antoniadi.——*Probable Papers*: Determination of Küstner's Magnitude Equation from Comparison of his Meridian Observations in Zones +24° to +27°, with Measures of Photographic Plates taken at the University Observatory, Oxford: H. H. Turner.—On the Place of the Variable RU Herculis and Neighbouring Stars, from Photographic Measures: F. A. Bellamy.—First Reduction of Photographs of Eros made at Cambridge for the Determination of Solar Parallax: A. R. Hinks.

MALACOLOGICAL SOCIETY, at 8.—Note on the Type-specimen of *Belemnoteuthis montefiorei*, J. Buckman: G. C. Crick.—Description of Two New Helicoid Landshells from British New Guinea: H. B. Preston.—On the Fate of the Type-specimen of *Voluta roadknightae*: Mrs. A. F. Kenyon. Description of a New Species of *Helicina* from Guatemala: E. R. Sykes.

MONDAY, NOVEMBER 11.

ROYAL GEOGRAPHICAL SOCIETY, at 8.30.—Opening Address: The President.—The Uganda Protectorate, Ruwenzori and the Semliki Forest: Sir Harry Johnston, K.C.B.

TUESDAY, NOVEMBER 12.

INSTITUTION OF CIVIL ENGINEERS, at 8.—The Discharge of Sewage into a Tidal Estuary: W. Kaye Parry and Dr. W. E. Adeney.—Train Resistance: John A. F. Aspinall.

MINERALOGICAL SOCIETY, at 8.—Anniversary Meeting.—*Papers*: On Baumhauerite, a New Mineral, Dufrénosite and Hyalophane, from the Binnenthal: R. H. Solly.—Analyses of Marshite and Miersite: G. T. Prior.—On the Hornsilvers: G. T. Prior and L. J. Spencer.—On Gibbsite from the Palni Hills in Southern India: Dr. H. Warth.—On the Occurrence of Gold in the Klondike; Results of a Visit in 1901: Prof. H. A. Miers, F.R.S.

THURSDAY, NOVEMBER 14.

MATHEMATICAL SOCIETY, at 5.30.—Linear Groups in an Infinite Field: Dr. L. E. Dickson.—Note on the Algebraic Properties of Pfaffians: J. Brill.—On Burmann's Theorem: Prof. A. C. Dixon.—The Puiseux Diagram and Differential Equations: R. W. H. T. Hudson.—Determination of all the Groups of Order 168: Dr. G. A. Miller.—An Outline of a Theory of Divergent Integrals: G. H. Hardy.—On the Representation of a Group of Finite Order as a Permutation Group; and on the Composition of Permutation Groups: Prof. W. Burnside, F.R.S.

FRIDAY, NOVEMBER 15.

EPIDEMIOLOGICAL SOCIETY, at 8.30.—The President, Dr. Patrick Manson, C.M.G., F.R.S., will deliver his Inaugural Address on the Ætiology of Beriberi.

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THURSDAY, NOVEMBER 14, 1901.

A CANADIAN NATURALIST.

Wild Animals I have Known. By Ernest Seton-Thompson. (New York City: Scribner and Sons.)

The Trail of the Sandhill Stag. (New York City: Scribner and Sons.)

The Biography of a Grizzly. (New York: *The Century* Company.)

MR. ERNEST SETON-THOMPSON, Naturalist to the Government of Manitoba, is an American author and artist whose works enjoy a wide popularity in his own country, but are less known than they deserve to be on this side of the Atlantic. He has written books on the birds and mammals of his State and done other more or less scientific work, but owes his fame, perhaps, rather to three lighter volumes, beautifully got up and illustrated by himself, with the assistance of his wife, the companion in his later wanderings. These are "Wild Animals I have Known," first published in 1898 and already, early last year, in an eighth edition; "The Trail of the Sandhill Stag," and latest, and perhaps most powerful of the three, "The Biography of a Grizzly."

The full-page drawings in all three books are finished works of art, and many of the little marginal sketches—scraps of boughs and berries, and suggestions in a few strokes of footprints in the snow and woodland and mountain scenes—would have delighted Ruskin.

At one time in his life a wolf-trapper, Mr. Seton-Thompson is, in the highest sense of the word, a field naturalist; and, gifted with a poet's imagination, has identified himself, with a completeness which few writers have reached, with the wild creatures whose lives and surroundings he paints. The key-note of his writings is struck in the preface to the first of the three books:—

"A moral as old as Scripture, We and the beasts are kin. Man has nothing that the animals have not at least a vestige of, the animals have nothing that man does not in some degree share. . . . They surely have their rights."

When caught hand and foot in wolf traps which he had been carelessly setting, and from which in the end he was freed only by the intelligence of a faithful dog, who, after one or two fruitless attempts to help him, brought him the trap wrench which had lain just beyond his reach, he remembered as the prairie wolves howled round him, drawing closer and closer, "how old Giron, the trapper, had been lost, and in the following spring his comrades found his skeleton held by the leg in a bear trap," and a "new thought came to him"—"This is how a wolf feels when he is trapped." "Yan," in "The Sandhill Stag," alone and far from help of any kind, on the trail of the muckle hart, in the mid-winter moonlight hears across the frozen snow the gathering hunting cry of the wolves, nearer and nearer, until it suddenly flashes upon him, "It is my trail you are on! You are hunting me." When at last within fifteen feet of "the great ears and mournful eyes" of his tired-out quarry, he remembers how he felt then, and cannot shoot. He had "found the Grail," and "learned what Buddha learned" more than 2000 years ago.

Where all alike are excellent, none can well be best; and of the wild animals which Mr. Thompson "has known" and writes of it is not easy to make a choice.

There is the "Springfield fox," who shook the dogs off when she thought proper by "the simple device of springing on a sheep's back," and who, when, in spite of gunshots, she had tried for three nights to bite through the chain which held her cub, and found all her attempts to free him useless and danger faced for nothing, brought him poison and was never again herself seen or heard of in the neighbourhood.

There are "Wully," the four-legged Jekyll-Hyde, a faithful sheep-dog by day; and at night a treacherous, bloodthirsty monster, who, when found out, flew straight at the throat of the girl to whom he had always professed especial devotion; and "Silverspot," the canny old leader of the band of crows which had their head-quarters on a pine-clad hill near Toronto; and others, not less interesting, sketched by a master-hand.

The most striking figure in the first book, second only, if second, to the grizzly who has the honour of a volume to himself, is "The King of Currumpaw," a great wolf who, with his pure white mate and a chosen band of five, all wolves of renown, terrorised one of the vast cattle ranges of New Mexico, and with a price of 1000 dollars on his head—an unparalleled wolf-bounty—scorned all hunters, "derided all poisons, and continued for at least five years to exact tribute from Currumpaw ranches to the extent, many said, of a cow each day."

The band seldom condescended to eat mutton, confining themselves almost entirely to the best cuts of year-old heifers; but for the mere fun of the thing stampeded and killed sheep by hundreds.

Mr. Thompson gives an instance of the grim bandit's diabolic cunning which came under his own observation.

"Sheep," he writes, "are such senseless creatures that they are liable to be stampeded by the veriest trifle, but they have deeply ingrained in their nature one, and perhaps only one, strong weakness, namely, to follow their leader. And this the shepherds turn to good account by putting half a dozen goats in the flock of sheep. The latter recognise the superior intelligence of their bearded cousins, and when a night alarm occurs they crowd around them, and usually are thus saved from a stampede and are easily protected. But it is not always so. One night in last November two Perico shepherds were aroused by an onset of wolves.

"Their flocks huddled around the goats, which, being neither fools nor cowards, stood their ground and were bravely defiant; but, alas for them, no common wolf was heading this attack. Old Lobo, the weir-wolf, knew as well as the shepherds that the goats were the moral force of the flocks, so hastily running over the backs of the densely packed sheep, he fell on these leaders, slew them all in a few minutes, and soon had the luckless sheep stampeding in a thousand different directions."

It was not until "the grand old outlaw" had lost his consort and become reckless, following her body to the ranch-house and tearing the watch-dog to pieces within fifty yards of the door, that he met his end at the hands of his biographer, who had come by special invitation to the Palette Ranch to match his cunning with the great wolf's.

"Wahb," the hero of the book last on the list, is, like the king wolf (whose portrait, admirably drawn—"Lobo,

Rex Corrumpæ"—appears at the end of his memoir), a real character—a sullen and solitary bear of enormous size, responsible for the deaths of at least two cowboys, and believed never to have had a mate. He was known far and wide over a broad district of New Mexico as "the worst grizzly that ever rolled a log in the Big Horn Basin"; but in the Yellowstone, where for some years he regularly passed two months in summer, and where, as in our London parks—to compare small things with great—wild things at once grow tame, he managed to pass himself off as "a peaceable sort."

From facts gathered from hunters, miners and ranchmen, and from personal experiences, Mr. Thompson has imagined and written his life through "cubhood," "days of strength" and "waning," from the time when he and his two brothers and a sister—an unusually large family for a grizzly—as woolly cubs "hustled and tumbled one another in their haste to be first at the ant-heaps which a mother's strong arm unroofed, and squealed like little pigs, and growled little growls, as if each was a pig, a pup and a kitten all rolled into one," until the time when, a grey-bearded old bear, crippled with rheumatism, dethroned and driven from his haunts by a usurper whom a year or two before he would have despised, he limps "with shaky limbs and short uncertain steps to the mysterious 'Death Gulch'—that fearful little valley where everything was dead and where the very air was deadly," and "as gently went to sleep as he did in his mother's arms by the Gray-Bulls long ago."

It is a powerfully written and wonderfully graphic story, more particularly in the earlier chapters, where the poor little cub, sole survivor of the family, wanders motherless in the woods, with all the world against him, to learn by the slow lessons of experience all about traps and guns and beasts and, worst of all, men, and the meanings of the many subtle messages which reached the brain by way of his "great moist nose," storing up wrath against the day of vengeance, which came with his strength.

One of the most interesting things in the book is the account of the way in which a big bear, when he takes possession of a country, advertises his proprietary rights by rubbing himself, whenever he passes, against particular trees.

"Wherever Wahb went he put up his sign-board—
'TRESPASSERS BEWARE!'
It was written on the trees as high up as he could reach, and everyone that came by understood that the scent of it and the hair in it were those of the great grizzly Wahb."

A critic, to assert his superiority, must pick holes somewhere. Perhaps in the case of Mr. Seton-Thompson's almost altogether perfect work, the least unreasonable way of doing what is expected is by hinting a doubt whether the vein of melancholy which runs through much of his writings is not a little strained.

"The life of a wild animal," he tells us in italics, "*always has a tragic end.*" Perhaps so; if, but only IF, sudden destruction coming unawares to end a bright existence—Death appearing without "the painful family," "more hideous than their Queen"—is necessarily a tragedy. But the world, after all, is something more than a great slaughter-house. There is, for the humbler creation at least, a "blindness to the future kindly given," and, so far as we can judge, a keen power of enjoying the present. The blackbird is not always thinking of the sparrowhawk, the ant of the turkey, nor the turkey of Christmas. The necessity for keeping the protective sense constantly on the alert may be the very best means for keeping the faculties of enjoyment bright and polished.

"A certain number of fleas," according to David Harum, "is good for a dog. They keep him from brooding on being a dog." T. DIGBY PIGOTT.

ELEMENTARY GEOMETRY.

Elementary Geometry, Plane and Solid, for use in High Schools and Academies. By Thomas F. Holgate, Professor of Applied Mathematics in North-Western University. Pp. xi+440. (New York: The Macmillan Company. London: Macmillan and Co., Ltd., 1901.) Price 6s.

THIS book covers the ground of the first six books and those parts of the eleventh and twelfth books of Euclid which are usually read; and it includes besides a discussion of the elementary properties of the simpler solid figures, the sphere, the cylinder and cone. There is also a brief appendix on trigonometry.

The introduction deals with preliminary notions and definitions, and the first chapter with triangles and parallelograms. The second chapter treats of the circle in a manner which is more direct than Euclid's, and is free from the impossible figures so bewildering to a beginner. It contains an interesting Article 204, on the principle of continuity, in which instances are given of propositions which, though very different at first sight, can by the application of the principle of continuity be harmonised under one general statement. Illustrations of this kind are most helpful and stimulating.

The third chapter, on similar rectilineal figures, contains a section on measurement, ratio, proportion and the theory of limits. As no definite agreement has yet been arrived at among teachers as to the best mode of treating this part of the subject, it is to this section that the main interest of the book is due. There is much to be said for the view of those who would definitely postpone any discussion of incommensurables to a later stage, but as it may be inferred from the book that this is not the view of the author, it will not be considered here. In order to make clear the relation of his treatment to the usual English practice, it is necessary to state very briefly what that practice is. It is usual to direct beginners to learn the fifth definition (the test for equal ratios) by heart without any adequate explanation,[1] although it rests upon ideas of extreme simplicity. It is doubtful whether one pupil in ten thousand understands the definition, though a great many are able to apply it correctly to prove two important propositions in the sixth book, viz., No. 1, "The areas of triangles (and parallelograms) of the same altitude have the same ratio as the lengths of their bases have to one another," and No. 33, "In equal circles, angles, whether at the centres or circumferences, have the same ratio as the arcs on which they stand have to one

[1] The so-called algebraic explanations frequently supplied are inadequate.

another: so also have the sectors." For the proof of these two propositions *only* is the fifth definition usually employed. All the remaining properties of proportion required for use in the sixth book are either assumed or proved (it would be more correct to say they are supposed to be proved) algebraically. Some teachers, probably a small minority, use the syllabus of the Association for the Improvement of Geometrical Teaching. This syllabus, following Euclid's line of argument, *uses the properties of unequal ratios to prove properties of equal ratios*, thus making the proofs unnecessarily artificial and therefore difficult; so that, though it is quite possible for a clever pupil to follow the reasoning in each separate proposition, it is very difficult for him to grasp the argument as a whole.

In the book under notice the fundamental definitions of the fifth book of Euclid, viz., the test for equal ratios, No. 5, the test for distinguishing between unequal ratios, No. 7, and the definition of the compounding of ratios, with which may be included the definition of duplicate ratio, find no place. And it may be conceded at once that, if these definitions are not properly explained, it is much better that they should not appear in an elementary text-book, because the beginner, to whom the simple ideas on which they rest are not carefully expounded, is far more likely to make progress in geometry with the aid of Prof. Holgate's book than with an ordinary Euclid.

The author, after defining the ratio of two incommensurable magnitudes as the limit of a rational fraction, obtained by a definite process (Art. 229), proves a general theorem on limits, viz., "that if there are two variable quantities dependent on the same quantity in such a way that they remain always equal while each approaches a limit, then their limits are equal" (Art. 230).

With the aid of this, the two propositions, Euc. VI., 1 and 33, already referred to, are proved, and also the proposition "that a straight line parallel to one side of a triangle divides the other two sides in the same ratio," Euc. VI., 2 (first part).

Taking the proof furnished of this last theorem as a type, and leaving out of it the use made of the general theorem on limits quoted above, it may be pointed out that the proof is in effect a demonstration (though some expansion would be necessary to make this clear) of the proposition that if a certain definite process be applied to the segments of each of the sides of the triangle the result will be to determine the same irrational number[1] in each case, so that this irrational number may be taken as the measure of the ratio of the two segments of each side, and that consequently these ratios are equal. With such a change the treatment would accord with modern ideas regarding irrational numbers as set forth by Dedekind in his tract on continuity and irrational numbers[2] and now generally accepted.

But when such propositions as "that if two ratios are equal, their reciprocal ratios are equal" are required (see Arts. 234, 237–240), then the proofs supplied are valid for commensurable ratios only. This change in the mode of treatment should have been clearly indicated in the text or preface. To have proved these propositions on the lines on which the treatment of the subject of ratio had been begun would soon have carried the author beyond the comprehension of those for whom his book was intended. To have proved them upon Euclid's lines would have made it necessary to add a large number of additional explanations. This, however, was the only practicable logical alternative.

The fourth chapter deals with the areas of plane polygons and with the measurement of the circle. Archimedes proved that π lies between $3\frac{1}{7}$ and $3\frac{10}{71}$ by a consideration of the regular inscribed and circumscribed polygons of ninety-six sides. The author obtains a much closer approximation, but finds only a series of values increasing up to π by using the inscribed regular polygons. The result would have been more impressive if a series of values decreasing down to π had been found as well.

The sixth chapter deals with lines and planes in space. It is a matter of opinion whether the modes of constructing the perpendicular to a plane in §§ 403 and 408 are or are not more difficult than Euclid's; but these last are so useful in Spherical Trigonometry that it seems a pity they have not had more prominence given to them than is furnished by § 406. For a similar purpose it would have been useful to give some further account of the angles between a line which meets a plane and the lines in the plane than Prop. xx. in § 449, viz., "The acute angle which a straight line makes with its own projection upon a plane is the least angle it makes with any line of that plane." It is advantageous to know, not only the least and the greatest angles between a fixed line meeting a plane and lines in the plane, but also the way in which the angle varies as the line in the plane revolves.

The statement of Prop. xxii., § 458, "that the sum of any two face angles of a trihedral angle is greater than the third angle," should be limited by inserting the word "convex" before the word "trihedral."

The seventh, eighth and ninth chapters deal with prisms, pyramids, cylinders, cones and spheres.

There are several features of interest in the book, such as the use of the principle of continuity in §§ 204, 264, 323, and the directions given in § 540 for constructing the regular polyhedra. The proofs of many of the propositions seem to be new. The work is evidently that of an experienced teacher, and is written on the lines of good class teaching, in which the teacher suggests steps in the argument to the pupil, and the demonstrations are worked out by both together. The book is calculated to arouse and stimulate those who have at heart the teaching of their subject.

MOSQUITOES AND MALARIA IN MAURITIUS.

Les Moustiques: Anatomie et Biologie. By A. Daruty de Grandpré and D. d'Emmerez de Charmoy. (Port Louis, Mauritius: *Planters' and Commercial Gazette*, 1900.)

THIS work is a contribution to the study of the Culicidæ, and principally of the genera Culex and Anopheles, of their *rôle* in the propagation of malaria

[1] An irrational number is defined as one which separates all rational fractions into two classes, an upper and a lower, such that
(1) Every fraction in the lower class is less than every fraction in the upper class.
(2) The lower class contains no greatest fraction.
(3) The upper class contains no least fraction.

[2] Translated into English by Prof. Beman. (Chicago: The Open Court Publishing Co., 1901.)

and filariasis, and of the means of guarding against them. The authors recognise in Mauritius only the types of fever quartan, tertian and æstivo-autumnal, and have proved *Anopheles costalis* to be the definitive host of their parasites in that island. Three species of Culex —*C. anxifer*, *C. albopictus*, *C. taeniatus*—were shown to be incapable of infection by parasites of human malarial fever. *Anopheles mauritianas* also appears to have no relation to human malaria. The chapters on classification, morphology, anatomy and biology add but little to the literature of these subjects. In the present state of our knowledge of the ætiology of malaria and filariasis a more careful description of the minute anatomy of the organs of the adult insect would have been extremely useful; probably difficulties in the preparation of complete and perfect sections have prevented the authors giving minute histological details. Descriptions of such important structures as the membranous portion of the pharynx, of the salivary receptacle, and of the muscles attached to them, and, in view of the importance of the recent discoveries of the presence of filarial larvæ in the labium of the proboscis, the relations and histology of this organ especially, should have claimed the attention of these naturalists. The spermatheca of the female insect is not referred to.

The authors are evidently not acquainted with the structure of the parts of the proboscis. The salivary duct is described as uniting the pharynx to the œsophagus. Careful histological preparations show that this is far from correct; the salivary duct traverses the neck and head below the œsophagus and pharynx, and, in the region of the common origin of the mouth-parts from the head, the duct opens into the salivary receptacle—a chitinous trumpet-shaped organ with a wide membranous proximal end into the middle of which the salivary duct opens itself; while the narrow distal end is applied to the upper end of a groove—the salivary canal—which runs along the whole length of the hypopharynx.

The cells of the epithelium of the stomach are described as :—(1) Large spherical cells, with protoplasm not stained by carbol-thionin, while the nuclei stain pale rose-colour and the nucleoli violet. These are said to be of lymphocytic nature. (2) Small spherical cells, with a deep violet-staining nucleus, and protoplasm which centrally stains with difficulty while the periphery is deeply stained. These the authors consider to be digestive in their functions.

The epigastric glands of the larval stage, eight in number, surrounding the anterior part of the stomach, and the dialysing tube or membrane in the stomach wall, are considered as playing an important part in the digestive functions of the carnivorous larva.

With regard to filariasis, the authors apparently found only *F. nocturna* in the blood of the people of Mauritius where elephantiasis also occurs, and they have been able to trace the complete life-history of the larval stage of this nematode in the thoracic muscles of *Culex anxifer*.

The authors do not appear to have recognised the presence of malarial parasites in the blood of native children, and hence do not refer to segregation of Europeans as a preventive measure. "Eviter les Anopheles" is their advice, and they uphold the opinions of Ross and others that, although, perhaps, absolute extermination of the insects will prove impossible, even in small areas, yet their numbers may, by the application of inexpensive and practicable means, be easily reduced to an almost harmless minimum. They rely chiefly on the use of culicicides, particularly of petroleum, and of culicifuges, such as terebinthene and naphthalene.

H. E. A.

OUR BOOK SHELF.

Disease in Plants. By H. Marshall Ward, Sc.D., F.R.S., Professor of Botany in the University of Cambridge. Pp. xiv + 309. (London: Macmillan and Co., Ltd., 1901.) Price 7*s.* 6*d.*

THIS is a very suggestive work, and the clearness with which Prof. Ward has treated a difficult and complex subject will ensure for his book a welcome on the part of the specialist, not less than that of the wider public to whom the volume is more immediately addressed.

Most treatises on plant pathology deal with the more extrinsic aspects of the matter, such as the host and the parasite, and some of them give accounts of the evil results of an unfavourable environment. But in the book before us the questions raised are discussed from a more philosophical standpoint. The effort is made to discern wherein disease itself really consists, and to ascertain the actual relations and changes involved in the transition from the healthy or normal to the abnormal and pathological condition. "Disease (not diseases) in Plants" is the title of the book, and it fully indicates the general purport of the contents.

In order to place the reader in a position to appreciate the nature of the connection between a healthy and a diseased state, the opening chapters are devoted to a consideration of the normal physiology of the plant-organs and their relations with their surroundings. Then the various disturbing influences which make for, or actually induce, disease are passed under review, and their operations as far as possible explained. The imperceptible gradations by which an organism passes from the healthy to an unhealthy condition are pointed out, and the oftentimes indirect operation of an unfavourable influence is insisted on. One is brought into closer quarters with the heart of the matter on recognising that the most injurious factors are those which operate through the metabolic processes of the plant; just as, it may be remarked, is malnutrition in the widest sense at the bottom of so many of the ills which the animal flesh assumes itself to have inherited. The interference may come through unfavourable conditions of life, or it may be more immediately traced to influences exerted by other organisms such as parasites and the like. And these considerations open the way for discussing the question of "predisposition" and examining the various avenues in this direction leading to possible remedial measures.

Of course in a work of this kind there are some views put forward which may not command universal acceptance, but they are chiefly those concerned with side-issues, and can hardly be profitably discussed within the limits of a brief notice. Enough, it is hoped, has been said to emphasise the fact that the book forms a valuable contribution to a subject of vast importance. For on the right understanding of the nature and causes of disease in plants hang many great commercial and even national interests. The annual loss incurred through the agency of disease is enormous, but the results of current work clearly demonstrate that much of this loss can be curtailed or prevented when its causes are understood and empirical remedies have given place to intelligent counteraction.

J. B. F.

Shell Life: an Introduction to the British Mollusca. By E. Step, F.L.S., &c. "Library of Natural History Romance." Pp. 414, 32 Plates, Figs. in text. (London: F. Warne and Co., 1901.) Price 6s.

COULD paper, print and pictures make a meritorious book, this would be one. The paper is of superior quality, and the print is exceptionally clear and clean; whilst the illustrations, although drawn from many sources, good, bad and indifferent, are well printed.

The thirty-two photo-process plates are excellent of their kind, their only fault consisting in the want of good arrangement in their component items and the inclusion of some objects far too minute for this method of illustration. Unfortunately there is no reference to them in the text, and the names cited on the plates do not always coincide with those given in the text.

The figures in the text are some of them very old friends, and saw service in the Rev. J. G. Wood's "Common Shells of the Sea-shore"; others are of later date and foreign extraction. Nor must we omit a word of praise for the binding and the tasteful and quaint, if not entirely appropriate, design on the cover.

It is a matter for regret, however, that the author did not make himself more familiar with his subject so that his work might have been something better than the mere outcome of industrious compilation from authorities more or less ancient. Thus he instances the patelliform as the primitive type of the molluscan shell; he is unaware of the existence of a rudimentary heart in Dentalium, and gives renewed currency to the blunder (founded originally on a mistranslation) that its embryo shell is bivalve; and so on, and so on.

In the matter of classification our author follows that of the Cambridge Natural History, which, having already been dealt with in these pages (vol. lii. p. 150), need not be further commented on here; nor shall words be wasted on the nomenclature employed, which is hopelessly out of date.

In the endeavour to confine scientific names entirely within brackets and furnish "popular" names where none such exist, the author is driven to translations, some of which recall those that once figured on the fossil fish tablets in the British Museum. As a rule derivations of names are, perhaps wisely, avoided; but we do meet with "Aplysia (from *a* and *plus*, unwashable)."

On the whole we incline to the opinion that the publishers did well to include this book in their "Library of Natural History Romance." (BV)^2.

Arithmetic. By R. Hargreaves, M.A. Pp. viii+416. (Oxford: Clarendon Press, 1901.) Price 4s. 6d.

IT is very difficult for an author to produce anything strikingly new in such a well-worn subject as arithmetic, and consequently this treatise greatly resembles two or three others of the most meritorious character. A good feature of the work is the attention which it devotes to the *theory* of arithmetic. Labour-saving processes, when long multiplications have to be performed and one of the factors possesses some particular simplicity of form, are frequently given—to the interest as well as to the advantage of the pupil.

If only our terrible system of weights and measures were replaced by the metric system, what a load of revolting and time-wasting work would be removed from the path of the English pupil! A short account of this system will be found in the present work.

Perhaps the explanation of the properties of recurring decimals is scarcely so complete and systematic as it might be. Here the use of a little algebra would do a great deal towards promoting in the mind of the pupil an understanding of the various rules for treating these decimals; and there seems to be no valid reason against the employment of algebra for such a purpose. Purely arithmetical proofs necessarily fail in generality.

There is a good section on approximative work which will be a great help to the learner. There are also sections on the square and cube root; but, with a logarithm book in our hands, the utility of arithmetical or algebraical processes for finding a cube root is more than doubtful.

The work abounds with examples, and with good hints to the pupil for shortening calculation and for choosing one mode of procedure in preference to another when two or more ways of doing a thing present themselves.

Intermediate Practical Physics. By J. B. Wilkinson. Pp. x + 154. (London: Chapman and Hall, Ltd., 1902.) Price 2s. 6d.

THIS book is for the intermediate and preliminary scientific examinations of the London University, and deals with experiments of a very simple kind. The exercises illustrate the various branches of physics, and they seem to be very suitable for beginners; but we regret that in many cases the descriptions are not accurate. Thus, in describing the measurement of the diameter of a sphere by placing it between two squared blocks, we are told to test the right-angles of the blocks by seeing whether they fit when placed on the table and then turning both blocks over. Surely this is no test. A little further on, in the account of the siphon barometer, the correction for change in density of the mercury and the expansion of the glass scale is attempted, but sadly needs revision and rearrangement. We should also like to know why the corrections for temperature are given with the siphon barometer and not with Fortin's pattern, where they must be equally important. Although many other points in the book require some correction, we think it is written on the right lines, as it aims at simplicity.

S. S.

Flowers of the Field. By the late Rev. C. A. Johns. 29th edition. Entirely rewritten and revised by G. S. Boulger, B.A., F.L.S., F.G.S., Professor of Botany in the City of London College. Pp. xlii + 926. (London: Society for Promoting Christian Knowledge, 1899.)

THE fact that this work should have passed through so many editions sufficiently proves its popularity. The present volume is an improvement on its predecessors, both by reason of the inclusion of new and valuable matter and by the excision of some that could be very well spared. The more definite and full descriptions of the species should aid in the identification of our British plants, but the illustrations still are capable of improvement. The book is, however, sure of a wide circulation amongst the large number of people who take an interest in, and desire a closer acquaintance with, the wild flowers of the country.

Correlation Tables of British Strata. By Bernard Hobson, M.Sc., F.G.S. (London: Dulau and Co., 1901.) Price 5s.

A SHORT time ago (NATURE, April 11) attention was called to the publication of Woodward's "Table of British Strata," also issued by Messrs. Dulau and Co. The present work is in some respects far more elaborate, as it comprises nineteen detailed tables ranging from Archæan to Pleistocene. The plan of the compiler is to give the subdivisions of each formation as determined in different regions in Great Britain and Ireland. Thus, to take the Cambrian, there are columns for North Wales, South Wales, Malvern Hills, Wrekin area, Nuneaton, North-west Scotland, and Ireland; and in these columns the various local divisions and their estimated thicknesses are given, together with references to original sources of information. No attempt is made to enumerate the

characteristic fossils, the leading zonal forms—*Olenellus*, *Paradoxides*, *Olenus* and *Dictyonema*—being the only fossils noted from the Cambrian system. In dealing with Ordovician and Silurian strata the graptolite zones receive particular attention, and other zonal fossils are mentioned. The full stratigraphical details relating to these systems make one feel that scant justice is done to the Devonian; but as a matter of fact our knowledge of that system is far less precise. Here, as occasionally elsewhere, a column for Continental divisions is given. In the Lower Carboniferous, Mr. Hobson starts with the Devon succession and places the Lower Culm Measures with the Coddon Hill Beds on the horizon of the Lower Limestone Shales, whereas their characteristic *Posidonomya* and *Goniatites* indicate an horizon equivalent to the Upper Carboniferous Limestone or Yoredale Series. He has not, however, ventured to indicate zones in the Carboniferous, although materials have been gathered in the neighbourhood of Bristol as well as in northern counties, to which reference is made in the preface. Here and there we would suggest a greater uniformity in method: for instance, the Ammonite zones of the Lias are noted under the names *Ægoceras*, &c.; those of the Inferior Oolite are noted as *Parkinsoni* zone, &c.; and those of the Cretaceous rocks as *Ammonites lautus*, &c. The most difficult correlation is, doubtless, that of the Pleistocene, and here the student may well pause, for the "Upper Boulder Clay" of different areas is not to be regarded as contemporaneous. Indeed, the compiler in his preface remarks that "strata named on corresponding horizontal lines cannot, in some cases, be considered to be of corresponding age"; and the student will do well to bear this in mind.

The work is issued as one of the museum handbooks of the Manchester Museum, Owens College. It cannot fail to be of great service for reference to geologists in general. It bears evidence of the most painstaking care and of wide research up to the date of publication; and we feel confident that the labour will be appreciated.

Die Partiellen Differential-gleichungen der mathematischen Physik. By Heinrich Weber, based on Riemann's lectures. Vol. ii. Pp. 527. (Brunswick: Fried. Vieweg and Son, 1901.)

IN reviewing the first volume of this book (NATURE, vol. lxiii. p. 390) it was pointed out that owing to the great advances in mathematical physics which have taken place in the forty years since Riemann's time, Prof. Weber had found it necessary, instead of merely issuing a revised edition of the well-known "Partielle Differentialgleichungen," to write practically an entirely new book. The present volume, which is written much on the same general lines as the first, is divided into five parts. The first contains the more important properties of hypergeometric series and their application to the theory of linear differential equations. The second part, dealing with conduction of heat, is much after the lines of Riemann's original treatment, and treats mainly of conduction in one dimension and conduction in a sphere. The third part is devoted to theory of elasticity and vibrations, the torsion problem being included in the former subject, and vibrations of strings and membranes in the latter. Electrical oscillations come next in order, and the last part consists of hydrodynamics and propagation of plane and spherical sound-waves, including Riemann's own theory of sound-waves of finite amplitude.

Seeing that a whole volume might be written on any one of these branches of mathematical physics and still leave many interesting points untouched, the treatment in the present book is necessarily but fragmentary in character, but Prof. Weber is to be congratulated on the number of points which he has been able to touch in the limited space of about 500 pages. At the end is an index to both volumes. G. H. B.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

The Total Solar Eclipse of September 9, 1904.

As inquiries have already been addressed to me as to the practicability of observing this eclipse, which passes across the Pacific Ocean (see "Nautical Almanac," 1904, pp. 487–490), perhaps I may be allowed, thus early, to communicate, through your instrumentality, the information I have collected on the subject.

The Walker Islands, which appear on some maps of the locality in the position 149° W., 4° N., would have been, if they existed, very favourably situated for the observation of the eclipse. But recent surveys have shown conclusively that they do not exist.

Kingman, or Caldew, Reef, 162° W., 6° N., is also favourably situated, but is stated in the Admiralty Sailing Directions to be partially dry at low water only.

Palmyra Island is placed by the most recent survey in the position 162° 6′ W., 5° 52′ N., and is thus a little too far south to be available. Proceeding westwards, the next group of islands encountered is the Marshall Islands. But even the most easterly of the group on the track of the eclipse—Aur—is too far west for our purpose, as the middle of the eclipse occurs there shortly after sunrise.

It appears that there is no island conveniently placed for the observation of this eclipse, and astronomers must wait for the total eclipse of the following August, which will afford ample opportunity for observation in Canada, Spain and North Africa.

A. M. W. DOWNING.

The Dilution of Acetylene for Heating Purposes.

YOU have been good enough on one or two previous occasions to give me a few lines in your columns on questions connected with acetylene for heating, and as this use of the gas is extending and will undoubtedly have a much wider extension in the near future, perhaps you will renew your courtesy in this matter.

In country places for domestic and laboratory purposes, more especially with the advance of electricity and decline of coal gas for lighting, the field for acetylene for heating is very large and has so far met with strangely little consideration. The combustion of a gas containing 92 per cent. of carbon successfully in a Bunsen burner is not more easy than its combustion to produce a trustworthy luminous flame. The chief difficulty from which we suffer in the former matter is the relatively high pressure under which the gas must be burnt. No one has yet devised a Bunsen burner which will give a flame large enough for ordinary working purposes under a pressure of less than six inches of water, and even then luminosity is not entirely banished, practically no margin being left for incorrect adjustment of the burner. The pressure is objectionable, it puts the gas fittings to a severe test in the matter of leakage, it is much more than is required for lighting and has to be specially arranged for in many generators, and in those of the automatic class it involves more "after gas," necessitating larger storage capacity. The fine orifice of the jet and the necessarily narrow tube with its accompanying increased internal friction and the large injecting power essential, all make high pressure a necessity. That this luminosity trouble is partly a matter of temperature can be easily shown by heating the tube of a non-luminous Bunsen, or pouring water on to the tube of one showing luminosity, the effect being very striking, and some improvements on these lines have suggested themselves and are efficient as far as they go. We want, however, to attack the root of the matter and dilute our acetylene to begin with, and this dilution would not be altogether objectionable from a lighting point of view. Lighting burners at present generally inject some air and can only themselves be regarded as on the verge of respectability; quite an absurdly small amount of benzene vapour is sufficient to put out of temper the lighting burners now on the market. Such dilution would give them the margin for bad usage which makes so much for success in practice, even though wasteful in theory.

In seeking a diluent, one turns naturally first to metallic carbides other than calcium, with the idea of finding a commercially possible carbide which will give methane or hydrogen on decomposition with water and could be blended with calcium carbide by the manufacturer to suit, if necessary, various requirements, when we should once more see the early attempts to use for lighting the ordinary household Bray burner repeated with success. Manganese carbide is stated to be easily formed, and by Moissan to be decomposed by water yielding equal volumes of methane and hydrogen, hausmanite (presumably prepared by heating pyrolusite) being recommended. An attempt on my part to make a few grams, though it is true that the amperes at disposal only just reached double figures, failed as regards any gas produced, although reduction undoubtedly took place. I should not presume to quote so insignificant an experiment had not the manager of the Acetylene Illuminating Co., who courteously gave me an interview some months ago, told me that the Company's experiments on this carbide (and science is indebted to the Company for a great many researches, which I hope it may see fit to publish) had not led to the production of a carbide at all easily decomposed by water. I suggested the use of manganese mud as being easily obtainable, very free from silica as compared with pyrolusite, not so highly oxidised, and in a very fine state of division, and I hope that the Company may see fit to try it. Among other carbides, that of aluminium seems to offer attractions for commercial investigation, and although magnesium carbide cannot be prepared in the electric furnace alone, I do not think that dolomite as a substitute for pure carbonate of lime has been experimented upon.

Failing a suitable carbide for dilution, will not some organic chemist come forward with a bye- or waste product which will decompose in the presence of hot caustic lime produced in the generator, with, if not the production of methane, hydrogen or carbon monoxide, at least some indifferent gas, such as nitrogen or carbon dioxide?

Investigations are wanted as to the amount of diluent required to banish luminosity under some standard conditions. I can only speak at present of carbon dioxide; a Bunsen burner consuming one cubic foot of acetylene per hour under six inches water pressure, showing a fully developed luminous zone rather greater in diameter than the sum of the widths of the non-luminous zone on either side, requires a supply of carbon dioxide at the rate of 0·15 cubic feet per hour to destroy completely this luminosity. A. E. MUNBY.

Felsted, November 1.

Magnetic Iron Ore as a Material for Concrete Blocks.

THE account of harbour works in NATURE of October 24 (p. 639) causes me once more to draw attention to the great advantage which would be gained by the use of magnetic iron ore as a material for concrete blocks. If magnetite is used instead of ordinary rock in the shape of fragments, and magnetic sand or ilmenite sand instead of common sea sand, concrete blocks can be obtained which have all the strength of the ordinary concrete blocks and which weigh, when immersed in water, exactly twice as much as the ordinary blocks. Such an increase in weight makes the magnetic blocks far superior as regards resistance to the waves. Work constructed with magnetic blocks will stand when other work will be destroyed. This superior effect of magnetic blocks is quite independent of the size of the blocks. The artificial increase of the size of ordinary concrete blocks is mentioned as a means of increasing the power of resistance, but there are certain to be some objections to this method, and if the great masses are ruptured after the rusting away of the cases, portions may give way. It is therefore better and more convenient to use the superior composition. As regards the expense, it may be mentioned that to obtain a good effect it is only necessary to use magnetic blocks for the most exposed spots of a dam, and more in the nature of a surface coating. There are immense natural deposits of magnetite, also of titanium ore, which latter is not of value for steel making, and it would surely be possible to obtain the necessary quantities in Scandinavia, or if for harbours in the East, then there would be inexhaustible supplies in southern India not too far from the coast. It has been argued that the iron ore would decay on exposure to sea water and that it would injure the cement. This may be true for inferior iron ores, but not for rich, pure magnetite and ilmenite, as I have proved by direct experiments. I have exposed fragments of magnetite to the action of filtered sea water in clean glass jars where every trace of decomposition would have been detected, but though I continued the test for a year the specimens stood the test very well. Moreover, I made sample blocks with Portland cement and subjected them to crushing tests, which showed them to be perfectly satisfactory as regards strength.

H. WARTH.

The San Clemente Island Goat.

LAST summer, at San Pedro, California, I was shown a goat which had just been brought over from San Clemente Island. Mr. Müller, the owner of the animal, told me that the goats of that island, running practically wild since the unknown date of their introduction, were all alike, constituting an easily recognisable race. The animal was quite reddish, about the colour of a red deer; front of face black; a pale (reddish) stripe down each side of nose, and enclosing the eye; cheeks black; chin light; ears blackish above; neck and anterior part of body strongly suffused with black. The light facial stripes were particularly distinct.

The Santa Catalina Island goats, I was informed, are variously coloured. This is doubtless due to the fact that Catalina is a popular resort, and fresh animals are frequently introduced.

T. D. A. COCKERELL.

East Las Vegas, New Mexico, U.S.A., October 27.

Food of Grass Snakes.

MAY I say, in defence of Dr. Gerald Leighton (see p. 625), that on two occasions I have found mice inside grass snakes. The first case was on a moor near Parkstone, Dorset, where on opening a smallish snake we found a mouse only partly digested. The other case occurred here last year, when I found a small shrew in a large grass snake. Also with regard to them swallowing birds, I have three times found birds inside them. In each case they were young ones; two were probably young larks (they were both in one snake), and the other was a young robin. C. M. ROGERS.

Wellington College, Berks, October 28.

THE OBSERVATORY OF MONT BLANC.[1]

IN observing the physical features of the Alpine regions, M. Vallot and the several members of his family show a devotion that no discouraging circumstances can damp, and an energy that rises superior to the inclemencies of the weather and the loneliness of the situation. His original observatory, constructed after much labour and in spite of many difficulties, was found to be in an unfortunate position, owing to the accumulation of snow with which neither labour nor expense could efficiently deal. Without hesitation this construction is abandoned, and in the light of greater experience a fresh site is selected and a new observatory built, where, from the peculiarity of configuration, snow cannot collect and interfere with the progress of the work. This building, constructed in 1898, admirably fulfils its purpose, and here, at an altitude of 4358 m., among the eternal snows, M. Vallot and his band of energetic labourers pursue their scientific avocations. These are sufficiently various, and in the present volumes we have the result of three distinct investigations, one dealing with the influence of barometric pressure on the chemical action of solar light, another on the velocity of water in streams and under glaciers, while the last gives an account of experiments undertaken with the view of detecting the rate and character of glacier motion.

Of the first of these discussions it is sufficient to say that the author aims at a re-examination of the adequacy of the formula found by Bunsen and Roscoe in similar researches, wherein occurs a numerical coefficient

[1] "Annales de l'Observatoire météorologique physique et glaciaire du Mont Blanc." Publiées sous la direction de J. Vallot, Fondateur et Directeur de l'Observatoire. Tome iv. Pp. ix + 189. Tome v. Planches du Tome iv. (Paris: G. Steinheil, Editeur, 1900.)

depending on the height of the barometer. M. Vallot adopts the same form of expression, but unfortunately does not give the means of comparing his numbers with those found in the earlier investigation. Moreover, the methods employed are not quite the same, and a slight difficulty arises from the selection of a silver salt whose maximum effect is not exhibited at the same part of the spectrum as in the case of Bunsen and Roscoe's inquiry. Making allowance for a slight discrepancy in this respect, we gather that while Bunsen and Roscoe claimed that 59 per cent. of the solar light was lost by transmission through the atmosphere, M. Vallot finds that only 40 per cent. is so lost. Treating the sensitised paper in such a way as to make the maximum sensibility coincide with the optical maximum, M. Vallot finds the coefficient of atmospheric transmission to be 0·826, corresponding with the mean of the values found by Bouguer, Leiden and Trépied. While the agreement quoted is quite satisfactory, we miss any reference to the work of Captain Abney on the Faulhorn (2683 m.), of Dr. Muller at the Etna Observatory (2944 m.), or of Prof. Langley on Mount Whitney (3513 m.). These latter authorities have all found a rather larger transmission coefficient than others who have worked nearer the sea level, and the greater altitude of the Mont Blanc Observatory might have afforded some explanation. Doubtless if the object be to inquire into the effect of the variation of a particular factor, there is an apparent advantage in conducting the observations in such a way that that factor is most materially affected, but the advantages can be considerably discounted by the extra difficulties introduced by the remoteness of the situation and other causes, and though M. Vallot and his assistants have striven manfully with the difficulties, greater weight would attach to his results if the observations had been more frequently repeated, though at a lesser height and with a smaller diminution of the barometric pressure.

The means employed for discussing the relative velocity of water in streams and torrents is discolouration of the water by means of a powder (fluorescin), which on dissolving rapidly gives rise to a green tint, and then observing the time at which the discoloured water arrives at a distant station. M. Vallot very properly insists upon the necessity of a sufficient expenditure of the powder, which can be determined experimentally according to conditions varying with the quantity of outflow that passes a given point, the colour of the water, &c. Observations made in this way do not permit of very great accuracy owing to the tendency of the coloured water to spread itself according to the character of the channel over which it passes, but when it is a question of determining the velocity in a subterranean channel, under glaciers, it is difficult to see what better means could be devised. M. Vallot has confined his attention mainly to the effect of the slope of the river bed on the rate of flow, and concludes that this is most rapid when the incline is about three in a hundred. As the slope increased, contrary to his expectation, the rate as measured horizontally, diminished. From this he concludes that the onward rush of water along steep ravines is more apparent than real. When the incline is very steep the effect is to hollow out the bottom, giving rise to great irregularities in depth which produce eddies and tend to stop the hurrying progress. It is therefore the mean velocity with which M. Vallot is concerned, and the distances measured vary from 1000 to 4000 m. The maximum velocity observed in the unconfined stream is 2·25 m. per second, and for a subterranean current of the same slope the progress is about one half of this quantity. The same ratio obtains between open streams and sub-glacier currents, whether the horizontal or vertical velocity be measured.

But the particular investigation to which M. Vallot has devoted the greatest attention is the movement of the glacier, Mer de Glace, in its various parts. Here the author enters into a very difficult inquiry, and it would be surprising if some of his results did not differ from generally received opinions. As a contribution to a more complete investigation the study made by M. Vallot is no doubt valuable, and much of his work, such as the difficult triangulation of the Mer de Glace, will be appreciated by later observers. But a complete theory of glacier movement is not to be derived by a study, however minute, of a single glacier in the space of a few years. An international commission under M. Forel has been at work for a considerable period and is probably still collecting data which show that the problem possesses many perplexing variations, not the least difficult being the evidence of periodicity in glacier movement connected with some obscure law that appears to affect the general climate of the earth. During the eight years that M. Vallot has been at work on this subject, he claims to have established the following prominent facts, which undoubtedly have reference to the particular phase of the motion which obtained in the period to which his observations have reference. We regret that it is impossible to enter with minuteness into the character of the evidence by which his conclusions are supported, but they may be briefly summarised thus: (1) That the progress of the glacier throughout the year is constant, the summer does not hasten nor does the winter witness any abatement of the uniform progress. Changes of incline of the bed on which the glacier moves will always explain any observed variation of velocity. (2) That the uniformity of the velocity in all seasons is opposed to any theory of regelation, or, indeed, to any explanation in which changes of temperature play a part. (3) That the movement of the glacier does not partake of the character of a viscous fluid, the whole moving as one piece. M. Vallot thus sums up the result of his long and arduous labours, which have been pursued under great difficulties with considerable skill and over a large area. We can only hope that the experience he has gained will be still longer employed in this species of investigation. "La conclusion de ce travail est que *la progression des glaciers est causée par le glissement de la masse, sous l'action de la pente du lit, aidée par la poussée des parties postérieures.* La pesanteur seule parait être en jeu, à l'exclusion de toute action calorifique."

GEOLOGY AND METEOROLOGY.

THE subject of climatic changes has always been of absorbing interest to geologists, and they have been perhaps more puzzled to account for the occurrence of plants of temperate or even subtropical character in Arctic regions than for the occurrence of wide-spread Arctic conditions in temperate regions. To explain these changes in the northern hemisphere, the alterations in the distribution of land and water and consequent influence on the Gulf Stream, the modification of the internal heat of the earth, changes in the position of the earth's axis, variations in the amount of heat given off by the sun, the eccentricity of the earth's orbit, and even fluctuations in the amount of carbon dioxide in the atmosphere, have individually or collectively been invoked. The influence of ocean currents, as modified either by the elevation of a tract of islands to form a continental area or by the total or partial submergence of a continent, has naturally been regarded as of very great importance. Moreover, the effect which such changes would have on winds has not been neglected, although their local influence has not been fully realized.

The apparently wide extent of tropical and subtropical climates during past epochs, with evidence of progressive diminution in temperature in later Tertiary times, has been held to be due to astronomical rather

than geographical causes. According to M. Eug. Dubois[1] one obscure enigma is that relating to the glacial episode which has been recognised in parts of India, Australia and South Africa in Permo-Carboniferous times. In those subtropical regions the débris from snow-clad mountains had been able to reach sea-level and be commingled with organic remains of almost tropical character. Other evidence, however, tends to show that there was no general lowering of temperature in this ancient epoch, but that there must locally have been mountains of considerable altitude, and that meteorological conditions were favourable to the development of huge glaciers. So also in the case of the far earlier pre-Cambrian period, during which it is believed that glaciation occurred. In connection with the phenomena M. Dubois discusses the evolution of the sun and the various influences affecting radiation of heat, maintaining that the general evidence of higher and more uniform temperature over the earth's surface prior to middle Tertiary times is well established, and is not interfered with by evidences of extensive though restricted glaciation.

In drawing attention to the influence of winds upon climate during the Pleistocene epoch (*Quart. Journ. Geol. Soc.*, August 1901), Mr. F. W. Harmer has opened up inquiries of considerable and far-reaching interest. Remarking that seasons abnormally warm or cold, rainy or dry, may be caused by the prevalence of particular winds, though the course of the oceanic circulation remain the same, he justly remarks that permanent alterations would equally result were the direction of the prevalent winds permanently changed.

Having attentively studied the causes and influence of areas of high and low pressure, he concludes that the climate of the northern hemisphere could not have been wholly cold during any part of the Pleistocene epoch, and that consequently the period of maximum glaciation in North America could not have coincided with that which affected the British Isles.

Regions covered by ice would have been to a greater or less extent anticyclonic at all seasons, low pressure systems prevailing elsewhere. The northerly winds on one side, either of a cyclonic or an anticyclonic centre, are the necessary equivalent of the southerly winds on the other, the direction in the northern hemisphere in the case of the anticyclone being like that of the hands of a watch, and in the case of a cyclone in the opposite direction.

Thus the effect of the anticyclone of an ice-sheet extending eastward from Greenland, over Great Britain, Scandinavia, and Northern Europe, would have been to change the prevalent alignment of the low-pressure system of the North Atlantic, producing warm southeasterly winds in Labrador and New England during the winter, instead of the northerly winds now prevalent there. The alteration in the direction of the winds would have tended, moreover, to divert the warm surface-currents of the North Atlantic from the European to the American coast.

It is admitted by Mr. Harmer that the maximum glaciation of Great Britain could only have taken place at a time when the Icelando-British channel was closed, either by an elevation of the submarine ridge connecting those countries or by its being blocked with ice. Thus, although the winds have naturally a most powerful influence, which he has done good service in pointing out, he is led to consider that to differential earth-movements of elevation and subsidence in different parts of the northern hemisphere may have been due the suggested shifting of glacial conditions from one side of the Atlantic to the other, and the alternation of glacial and interglacial periods in the eastern and western continents. In this way the milder periods which locally prevailed at intervals during the Pleistocene epoch would be attributed to meteorological and geographical rather than to astronomical causes.

[1] "Les Causes probables du Phénomène paléoglaciaire permo-carboniférien dans les basses latitudes." *Archives Teyler*, vii., Partie 4. (Haarlem, 1901.)

ANIMAL PHOTOGRAPHY.[1]

THE advantages of photography as compared with wood-engraving for the illustration of works on natural history are in many ways so great that any attempt to perfect and popularise the methods in use should be heartily welcomed. Quite apart from artistic effect, the great superiority of photography is that it ensures absolute accuracy, and, when living animals are the subjects, shows them in natural attitudes. In wood-engraving there are several sources of error which only too frequently make themselves apparent. In the first place, the draughtsman may make a blunder. But too often it is the engraver who is in fault, very frequently from mistaking the nature of some feature in the drawing he has to reproduce. For example, the author of the volume before us calls attention to a curious engraver's error in a well-known popular work, where, from some misconception, the mouth of a stickleback appears in a totally wrong position.

Such errors are, of course, impossible in photographs and photogravures. Nevertheless, photography has

FIG. 1.—Hedgehog.

certain disabilities of its own in regard to animal portraiture. A trained zoological draughtsman, whose object should be to produce a *characteristic* rather than an *artistic* picture, always takes care to draw his subject in a position which will show to the best advantage its distinctive features, whether of form or colour, and for this purpose he generally consults the specialist for whom the sketch is undertaken. The photographer, on the other hand, is usually content to "snap" the animal he has in hand in any effective pose, with the too frequent result that his picture, from a zoological point of view, has comparatively little value. That is to say, the features by which alone the affinities of the animal can be decided are either not shown at all, or are but imperfectly displayed.

One of the main objects of the present work appears to be to instruct photographers how to avoid these effects

[1] "Photography for Naturalists." By D. English. Pp. 132. Illustrated. (London: Iliffe, 1901.) Price 5s. net.

As a case in point, the author takes the natterjack toad. "There are three particular features about the natterjack toad," he writes, "which distinguish it from the commoner variety. It has a yellow stripe down its back, its hind feet are not webbed, and it has a peculiar running method of progression. A really good illustration of this toad would show these three distinctive features. A photograph might easily be produced which would show none of them—a side view, for instance, of the toad sitting still—and such a photograph would probably be the one taken by a photographer who had not troubled to make himself acquainted with his subject."

The author then proceeds to show the methods necessary in order to procure the desired results. Elsewhere he states that for photography of this description the only satisfactory way is to keep the animals whose portraits are desired in confinement for some little time, when they soon become sufficiently tame not to mind the approach of the artist with his camera. It will, of course, be obvious in this connection that the photographer must either be a good practical naturalist himself, or that he must consult someone duly qualified to point out the characteristic features of the animals about to be taken.

Not less important than the display of an animal's distinctive structural peculiarities is the reproduction of its characteristic attitudes. In this respect nature fortunately comes to the artist's assistance. "Living creatures," as the author truly observes, "adopt their characteristic attitudes more frequently than any others. The photographer has, therefore, to learn which attitudes his subjects most frequently adopt, and should endeavour to perpetuate them in his store of negatives."

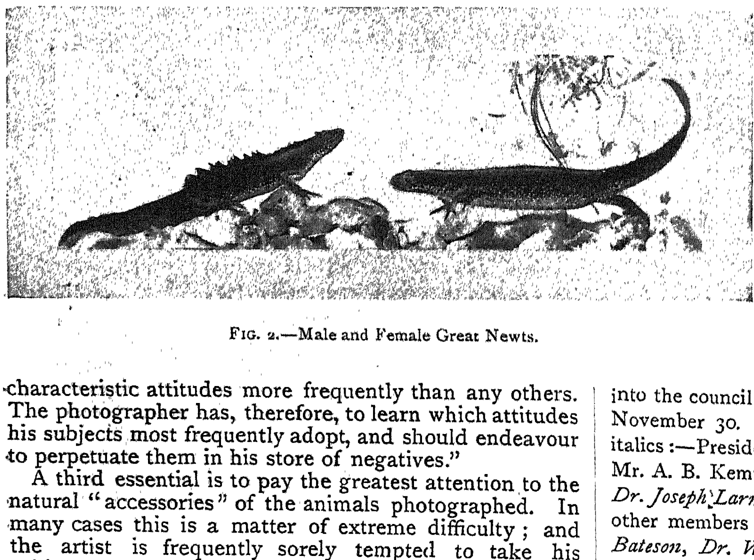

FIG. 2.—Male and Female Great Newts.

A third essential is to pay the greatest attention to the natural "accessories" of the animals photographed. In many cases this is a matter of extreme difficulty; and the artist is frequently sorely tempted to take his subject when in a favourable pose amid incongruous surroundings. Should this course have to be taken—and in some cases it is almost unavoidable—the author advises blocking out the animal and making a fresh negative with a suitable background.

Mr. English is careful to distinguish animal photography of the above nature from what he terms "stalking" photography, when the animal is approached stealthily in its native haunts with the camera, or the camera is concealed in a suitable position to await its arrival. And he renders full justice to the excellent results which have been obtained by the Messrs. Kearton in this branch of the subject.

In the main the author deals with British animals, of which he gives some exquisite pictures. Two of these, by the courtesy of the publishers, we are enabled to reproduce, so that our readers can judge for themselves as to their merits. While it is no doubt of the highest importance to have a large stock of life-like portraits of our native animals, the number of photographers who labour in this field will probably ere long produce a sufficiency. For scientific zoology the portraits of rare foreign animals are still more essential; and in a future edition it may be hoped that the author will see his way to urging his fellow-workers to take up this part of the subject in real earnest.

A large portion of the work is, of course, devoted to the *technique* of the subject; but this we may well leave to the consideration of practical photographers.

The author has done good service in endeavouring to impress on his fellow-workers the importance of producing animal portraits which shall satisfy the requirements of zoologists, and we sincerely trust that his efforts to promote improvement in these matters will not be in vain. The book should be in the hands of every photographer as well as of every naturalist. R. L.

NOTES.

THE Royal Society's medals have this year been adjudicated by the president and council as follows:—The Copley Medal to Prof. J. Willard Gibbs, For. Mem. R.S., for his contributions to mathematical physics; a Royal Medal to Prof. William Edward Ayrton, F.R.S., for his contributions to electrical science; a Royal Medal to Dr. William Thomas Blanford, F.R.S., for his work in connection with the geographical distribution of animals; the Davy Medal to Prof. George Downing Liveing, F.R.S., for his contributions to spectroscopy; and the Sylvester Medal to Prof. Henri Poincaré, For. Mem. R.S., for his many and important contributions to mathematical science. His Majesty the King has been graciously pleased to approve of the award of the Royal medals. The medals will, as usual, be presented at the anniversary meeting on St. Andrew's Day (November 30). The Society will dine together at the Whitehall Rooms on the evening of the same day.

THE following is a list of those who have been recommended by the president and council of the Royal Society for election into the council for the year 1902 at the anniversary meeting on November 30. The names of new members are printed in italics:—President, Sir William Huggins, K.C.B.; treasurer, Mr. A. B. Kempe; secretaries, Sir Michael Foster, K.C.B., and *Dr. Joseph Larmor*; foreign secretary, Dr. T. E. Thorpe, C.B.; other members of the council, Prof. H. E. Armstrong, *Mr. W. Bateson*, *Dr. W. T. Blanford*, *Prof. F. O. Bower*, Mr. C. V. Boys, *Prof. W. Burnside*, *Prof. W. W. Cheyne, C.B.*, *Prof. G. C. Foster*, Prof. W. M. Hicks, *Mr. Frank McClean*, *Prof. H. A. Miers*, *Sir John Murray, K.C.B.*, Prof. J. Emerson Reynolds, Dr. R. H. Scott, Prof. C. S. Sherrington, and Mr. J. W. Swan.

ON November 24 a medal will be presented to M. Berthelot, in the large amphitheatre of the Sorbonne, to commemorate his services to science. M. Berthelot's activity during more than fifty years has been extraordinary, and there are no branches of chemistry on which he has not made his mark. His last publication is "Les Carbures d'hydrogène," a work in three stately volumes, comprising an account of his labours on these compounds during the last half-century. To mention only some of M. Berthelot's achievements, his researches on the synthesis of the natural fats, his discovery of polyhydric alcohols, his work on explosives, on the fixation of nitrogen by plants, his long investigations in the domain of thermal chemistry, and the contributions which he has made to the history of chemistry, constitute a record of work which, it is not too much to say,

has not been equalled since the time of Berzelius. The presidents of the Royal and the Chemical Societies have been asked to be present to represent English science, and the President of the Republic will do honour to this eminent man of science by presiding at the celebration.

THE list of birthday honours includes the name of Prof. A. Pedler, F.R.S., Director of Public Instruction, Bengal, who has been made a Companion of the Order of the Indian Empire.

PROF. A. FISCHER DE WALDHEIM, the director of the Botanic Garden at St. Petersburg, has just commenced the publication of a periodical *Bulletin* of the Gardens.

THE Imperial Academy of Sciences of Vienna has received intelligence of the botanical expedition in Brazil, from its chief, Prof. R. von Waldheim, down to September 10, from São Paulo. The rivers Rio Branco, Rio Mambu, and Rio Aguapihy, flowing through an almost unexplored country, had been navigated in canoes; and large consignments have already been sent to Vienna in the form of living plants and roots, herbarium specimens, preparations in spirit, woods, fruits, and economic products.

WE have received from Major Ross the "First progress report of the campaign against mosquitoes in Sierra Leone" (Liverpool School of Tropical Medicine, *Memoir* v. part i.), in which is detailed the methods of procedure and the results up to date of this interesting attempt to reduce the numbers of mosquitoes in a district. The works carried out include the removal of rubbish, especially empty tins and broken bottles, which form breeding places for Culex and Stegomyia (the supposed yellow-fever host), and the filling up and drainage, or brushing out and treating with crude petroleum, of the puddles which harbour Anopheles. Dr. Taylor, who is in charge of the expedition, writes that it is now (September 28) difficult to find Anopheles, Stegomyia is getting very scarce, and Culex is only seen now and again. Dr. Daniels, of the London School of Tropical Medicine, gives testimony to the same effect in a report at the end. The expedition is intended to be an object-lesson in the manner of ridding tropical towns of mosquitoes by drainage and cleaning, and has been financed by private munificence.

ROPE railways have for some time been in use for the conveyance of iron ore and stone in districts where, owing to the nature of the country, ordinary railways would be impracticable. One of the latest examples of these has recently been constructed in Ireland between Ballinphellic and Ballinhassig by the Cork, Bandon and South Coast Railway Company. It is intended for the conveyance of bricks from the works of the Cork Brick Manufacturing Company, situated about eight miles from Cork. The line is four miles in length and has a transporting capacity of twelve tons per hour. There are 126 buckets, which travel at the rate of four miles an hour, each holding 3½ cwt. The rope is of steel, and there are forty-three supports consisting of steel trestles, the height of which is sufficient to allow the buckets to travel overhead clear of all obstructions. The loads automatically take on and leave the cables at the stations without any separate coupling operations. The line is worked by a stationary engine, and it requires 12 h.p. to drive the rope. The cost of transport of bricks to Cork has been reduced from an average of 18*s.* per thousand to 5*s.*

IN the Swedish journal *Jernkontorst*, a description is given by Mr. G. F. Heindenstam of the conversion of the wood waste and sawdust from the saw-mills in that country into charcoal. The waste pieces of wood cut off in the conversion of the logs are passed through rolling-mills designed for drying out the greater part of the moisture and reducing the wood to the form of sawdust. This is then passed on to heated presses and the carbonising apparatus. In these the liquid bye-product is distilled and the solid matter converted into briquettes. A plant consisting of light carbonising apparatus can deal with 9000 tons of waste wood and sawdust, from which 6000 tons of charcoal briquettes are made, the remainder being used as fuel for driving the machinery. These yield 2006 tons of charcoal, having a market value of from 2*l.* 5*s.* to 3*l.* 6*s.* per ton, besides 530½ tons of tar, 300 tons acetate of lime, and 45 tons of methylic alcohol and acetone. The total yield from these is 11,487*l.*, the cost of conversion being 7661*l.*, leaving a profit of 3826*l.* after allowing 2550*l.* for the value of the waste wood and sawdust, and 10 per cent. on a capital of 16,666*l.*

A PAPER has been contributed to the Vienna Academy of Sciences by Prof. J. M. Pernter on polarisation of light in turbid media, considered in reference to the colour of the sky. The author has observed the polariscopic effects and the relation of the polarisation to the colour in various emulsions of mastic in water, and a comparison has been made between these effects and those observed in the light of the sky. He finds that the two phenomena are in close agreement, and an experimental test is thus afforded of Lord Rayleigh's theory of the colour of the sky.

IN connection with the Austrian deep-sea expedition a paper has been published by the director, Herr Th. Fuchs, dealing with the character of the deep-sea fauna of the Red Sea. In spite of the prevailing high temperatures even at the greatest depths, the fauna is entirely of the character of a deep-sea fauna and resembles that of the open ocean. The deep-sea fauna, considered both as a whole and in regard to its individual species, shows considerable resemblance with the fauna of the so-called "Badner Tegel." Lastly, the peculiar fauna begins at a depth of about 200 metres, although the temperature at this depth is about 23° C., and is sufficiently high to allow of the growth of coral reefs.

VAN DER WAALS'S equation was undoubtedly an important step in obtaining a more approximate representation by a mathematical formula of the isothermal lines of fluids than was given by Boyle's law or similar formulæ. The further modifications proposed by Clausius, Tait and others, including, recently, Amagat, all tend to show that such formulæ are at best to be treated as mere approximations. The next step in advance, consisting in the expression of the equation of state of gases by means of series, forms the subject of a paper, by Dr. H. Kamerlingh Onnes, in the *Communications* from the Leyden Physical Laboratory, No. 61. Various forms of series were tried, and the most convenient was found to be an expansion of pv in descending powers of v. For the coefficients of these powers, which are, of course, functions of the temperature, series involving the temperature and its reciprocal as well as exponential functions of the reciprocal of the temperature were chosen. A closely allied subject, namely the precise isothermal of hydrogen at 20° C. up to 60 atmospheres, is dealt with by Mr. J. C. Schalkwijk in the preceding number of the *Communications*.

THE eleventh volume of the *Deutsches Meteorologisches Jahrbuch*, by Prof. Paul Bergholz, contains the meteorological observations of the town of Bremen for the past year. The volume is divided into six sections, the first two of which deal with the hourly and daily readings of the various meteorological instruments throughout the year, and the third with the results from the different rainfall stations for the same period. Part iv. contains the mean values of the readings of the self-recording instruments for the years 1896–1900 and 1891–1900, while part v. includes similar information from observations made three times a day. Of perhaps the greatest interest is the sixth

and last section, in which are brought together the results of the meteorological observations since they were commenced. Thus we find that the series for temperature commenced in the year 1803, that for rainfall in 1830, and pressure and humidity in 1876. The mean values are given in a very convenient form, being arranged according to intervals of a month, year, five years and ten years. There are also numerous other tables in which maxima values, minima values, temperature for each season of the year, number of frost days, &c., are separately dealt with. The volume closes with a table showing the mean values for the whole period of observation of all the meteorological elements for each month of the year, the mean temperature for every day of the year, and a set of curves illustrating many of the variations mentioned above and showing many of the mean daily variations.

THE International Aëronautical Committee have published their complete account of the results of the manned and unmanned balloon ascents which took place on November 8, 1900. The work contains the original observations, together with those taken at mountain stations, and special cloud observations on the day of the ascents. Dr. Hergesell has discussed the observations of each ascent with reference to barometric pressure, temperature and wind, and has shown on two charts the distribution of pressure and temperature at the sea level and surface of the earth respectively and at a height of 5000 metres. Great variations of temperature were exhibited in different localities, even up to the highest strata of air; the coldest districts lay in the north-west and the warmest in the south-east of the continent. At an altitude of 5000 metres, the temperature over Paris was about $-20°$ C. and over Vienna, $-11°$. The isotherms at 5000 metres run from S.W. to N.E.; that of $-10°$ extends from the north of the Adriatic to Moscow; that of $-15°$, from the south-west of France, across Germany and the Baltic to St. Petersburg, and those of $-20°$ and $-25°$ take a more northerly course, while over Ireland the air is cooled to $-30°$. The isobars at the above-mentioned altitude, like the isotherms, run generally from S.W. to N.E.; the pressure is lowest over the British Islands and highest over the S.E. of Europe. The wind velocity is best shown by the manned ascents; from the observations taken by Dr. Berson, the velocity rose from 8·3 metres per second at 1600 metres to 11·2 metres per second at 2300 metres, and he estimates that at altitudes above 6000 metres the velocity would be about 16 metres per second. The ascents were mostly made during anti-cyclonic conditions, and an inversion of temperature was generally observed, especially after reaching the limits to which the ground fog extended.

WE have received from Messrs. Isenthal and Co. a well-illustrated catalogue of electric heating and cooking appliances, which shows that this branch of electrical industry has been very fully worked out. It cannot be claimed for electrical heating that it is very economical, but its superior cleanliness and convenience are recommendations that are sure to lead in the course of time to its widespread use. A point strongly in its favour is that heat need only be generated at the time and the exact place at which it is required; an electrical cooking range can be shut down when not needed much more easily and completely than a coal fire. It is impossible to estimate the gain in cleanliness and healthiness which would result from a general adoption of electrical in place of coal or gas heating for domestic purposes, but the advantage is sure to be realised sooner or later, just as it is being realised in electric lighting, and we may hope in time to have a fogless London as a result. At present electric lighting companies have a business which is so rapidly expanding that it is, perhaps, not worth their while to take special pains to induce consumers to adopt electrical heating. The gain would all the same be very great to the supply companies, as it would give them a heavy day load. That there is already a considerable demand for electric heating apparatus is evidenced by the catalogue before us, which describes appliances for meeting almost every conceivable want, both for domestic and scientific or laboratory purposes. Some of the latter apparatus would be very convenient in laboratories where electric current is available, as it affords easier means of regulation and is safer than gas, and also allows any desired temperature to be obtained a second time with much less trouble.

WE have received from the publishers, Messrs. Iliffe and Sons, Ltd., the Christmas number of *Photography*, a number which will be welcomed by all interested in the art of picture making. No pains seem to have been spared to make the magazine all that could be desired in the way of quality of paper and printing, while the text is of very general interest and the reproductions of numerous well-known photographs excellent. In the opening article a brief account is given, with illustrations, of three of the foremost photographic artists in France, and we may suggest to those who are not familiar with their style of work that much may be learnt from the article. The second contribution is on a subject which interests every photographer, but the importance of which is not often thought of until too late. One recollects with regret how many good negatives would have been greatly improved if only a figure had been inserted or placed in another position or even omitted altogether. Valuable hints on this score will be found in the chapter entitled "the introduction of figures into landscape pictures," and much can be gathered from the excellent and appropriate illustrations. The main part of this publication is devoted to criticisms and reproductions of many pictures by well-known photographers, which, as is stated, is a reprint in a revised form from *Photography*. The number concludes with a set of sixteen borders with different designs for Christmas cards, all of which are copyrighted, but are placed at the disposal of amateurs and professionals desiring to use them for their own cards.

THE Imperial Department of Agriculture for the West Indies has issued a full report on sugar-cane experiments conducted at Antigua and St. Kitt's in the season 1900–1901. The report is in two parts, the first, of 32 foolscap pages, dealing with experiments with varieties of sugar cane, with an appendix on the chemical selection of sugar cane; and the second, of 78 pages, with manurial experiments. Mr. Francis Watts, chemist-in-charge, states that the variety and manurial experiments involved the analysis of the juice from upwards of 900 plots, while those on chemical selection necessitated the determination of the sucrose in 600 canes. Taking the mean results of the experiments in Antigua, cane D 95 occupies the best place with 8158 lb. of sucrose per acre in juice, Mont Blanc variety following with 7256 lb., while B 147, the best Barbados seedling, stands twelfth on the list with 6050 lb. The means for ratoon canes, however, place B 147 first with 7164 lb. In St. Kitt's, one of the most promising of the Barbados canes, B 208, stands first with 9817 lb., Naga B second with 8956 lb. and B 147 third with 8874, Mont Blanc and D 95 being respectively eleventh and twelfth on the list. On the question of chemical selection the results obtained were not conclusive. Polarising the juice of 200 "high" canes and 200 "low" canes, the difference proved so small that it may lie entirely within the limits of experimental error. The manurial experiments are fully described, with forty-three tables of particulars. They indicate the possibility of growing good crops of plant canes with the use of pen manure only (including such organic manures as green dressing), and when it is obtainable in sufficient quantity artificial manure is unnecessary. If there is no pen manure, fields in good condition will produce good crops

with the aid of artificial manures. What should be done with phosphate is not clear. Artificial manures are unremunerative on land in poor mechanical condition. It is recommended that energy should be devoted to raising pen manure rather than spend money on artificial manures. Experiments are being undertaken to determine whether it will be remunerative to use artificial manures in growing green dressings.

GEOLOGICAL surveys in the United States take a more comprehensive view of geology than is prevalent elsewhere, as they deal generally with natural history. The State Geologist of Alabama has issued a bulky volume on the plant life of the State, by Dr. Charles Mohr. In it are enumerated all the known species of native plants, with their synonymy, localities and mode of occurrence. The author makes some remarks on the spontaneous flora in its relation to agriculture, and observes that the fitness of the land for the production of a special crop can often be ascertained by the farmer from the character of the vegetation alone, without having to resort to costly and time-consuming experimentation.

THE Geological Survey of India has published an account of the Son Valley in the Rewah State and of parts of the adjoining districts of Jabalpur and Mirzapur, by Messrs. R. D. Oldham, P. N. Datta and E. Vredenburg (*Mem. Geol. Surv. India*, vol. xxxi. part i., 1901). The report is accompanied by a colour-printed map on the scale of an inch to four miles, and this shows the exposed areas of unfossiliferous and more or less metamorphosed rocks, a red shale series, and overlying divisions of the Vindhyan and Gondwana groups, which have been regarded as representing Silurian and Jura-Trias respectively. The present work relates almost wholly to the stratigraphical, petrographical and physical questions. There is an almost complete absence of minerals of economic value and apparently also of fossils. Special attention is drawn to the porcellanites of the Lower Vindhyan series, which are regarded as volcanic tuffs.

DR. FRITZ NOETLING describes the fauna of the Miocene beds of Burma ("Palæontologia Indica," new series, vol. i. 1901). Two groups of Tertiary strata are recognised; the lower, characterised by a marine fauna, is considered to be of Miocene age, and the upper, characterised by fluviatile and terrestrial forms of life, is regarded as Pliocene. The Miocene deposits yield remains of Anoplotherium, Crocodilus, Python and Myliobates, which suggest comparison with higher Eocene and Oligocene strata. The author, however, maintains that the beds are newer than the Bartonian (Eocene), and he has "purposely refrained from mentioning the Oligocene," as, in his opinion, "no evidence warrants the adoption of this name for any part of the Indian Tertiary system." The fauna is composed mainly of Lamellibranchs and Gasteropods, and these exhibit relationships with the Eocene of France and with the recent fauna of the western Pacific. Thirty per cent. of the species are direct ancestors of forms living in the Indian Ocean, but this recent fauna contains also a foreign, probably European, element of Miocene origin. One of the author's conclusions is that there was no direct communication between the Miocene Ocean of Europe and India during the Miocene period, as there is not a single species common to the two areas. The vertical range of the species is very restricted.

THE Report of Mr. Edgar Thurston, superintendent of the Goverment Museum, Madras, for the year 1900–1901 has reached us, and contains much interesting information concerning the work done in the various departments of the institution, particularly in the case of those devoted to anthropology, natural history and industrial economics. During the year under review four parts of the *Bulletin* of the Museum were issued, the contents of which have already been referred to in these columns.

THE Baschkirs are an interesting group of peop who live on the eastern slopes of the Urals; formerly they were all nomads, but they have been constrained by the Russian Government to become more or less settled, and they now constitute three groups—the forest- mountain- and steppe-Baschkirs. Hofrat Peter von Stenin gives in *Globus* (Bd. lxxx., Nr. 10, p. 150) an ethnographical illustrated sketch of these people, with references to the literature of the subject, but he omits the brilliant essay on their sociology by M. Edmond Demolins in *La Science Sociale* (tome ii., 1886, p. 405), which is based upon the observations of Le Play in the second volume of his "Ouvriers Européens." The difficulty with which a pastoral people take to agriculture is indicated by both the German and French authors in a manner characteristic of their several nationalities.

THE anthropological investigations in connection with the Madras Government Museum are being conducted with energy and ability, the last research being by Superintendent F. Fawcett on the ethnography of the Nâyars of Malabar. The account is published in the *Bulletin* of the Museum (vol. iii. No. 3) and is illustrated with eleven plates. The Nâyars, the Nareæ of Pliny, were the swordsmen, the military caste of the west coast of India. They are said to be the most complete existing example of inheritance through females. Their average stature is 1·656 m., the cephalic index 73·1, and nasal index 76·8; that is, they belong to the somewhat short, long-headed, distinctly dolichocephalic mesorhine group of the non-Aryans of southern India. The customs relative to marriage, birth, death are carefully narrated. The religion is described, special mention being made of serpent worship and certain festivals, and astrology and magic.

MR. C. J. HERRICK, the well known author of the "Mammals of Minnesota," contributes to the October number of the *Journal of Comparative Neurology* an important paper on the cranial nerves and cutaneous sense-organs of the North American cat-fishes, or siluroids. Starting with Merkel's discovery of the divisibility of the cutaneous sense-organs into two chief types—the "terminal buds" and "neuromasts," or organs of the lateral-line system—the author has endeavoured to ascertain whether these two types are supplied by different nerves, as has been thought probable by other investigators. The investigation has involved the complete working-out of the nervous system of the common American cat-fish, *Ameiurus catus*.

THE latest issue (vol. xxix. part iii.) of Gegenbaur's *Morphologisches Jahrbuch* contains five papers, all dealing with the morphology and development of the lower vertebrates. Prof. B. Haller discusses the primitive kidneys of the spiny dog-fish, Mr. H. L. Bruner the respiratory mechanism of amphibians, as exemplified by the myology of two genera, and Mr. J. F. Holm the finer anatomy of the nervous system of the lampreys of the genus Myxine. The first appearance of the olfactory organ in the larva of the true lampreys forms the subject of an article by Dr. W. Lubosch, while F. Hochstetter describes certain variations in the aortic arch and the bases of the arteries springing from the same in reptiles.

THE August issue (vol. iv. part i.) of *Annotationes Zoologicae Japonenses* contains five papers, for the most part on somewhat abstruse biological subjects, and thus bears witness to the thoroughness with which natural science is studied in Japan. In the first communication Prof. Mitsukuri discusses "negative phototaxis" in the Japanese periwinkles and its influence on their habitat. Knowing that these molluscs like shallow water, it is argued that when the depth becomes too great for their comfort they endeavour to escape by crawling in the direction which appears to them the darkest—that is towards the land. In a second paper Mr. S. Hatta reviews the lampreys of Japan;

while in a third Dr. Bashford Dean adduces evidence to prove the existence of vestiges of an original holoblastic cleavage in the egg of the Japanese representative of the Port Jackson shark. This discovery is of the highest morphological importance, sharks' eggs having been hitherto regarded as typically meroblastic. "No one, I fancy," writes the author, "would have been bold enough to have prophesied that the wide difference between the typically meroblastic egg of the shark and the holoblastic egg of such a teleostome as a sturgeon might come to be bridged over within the limits, not of fossil sharks, but of recent sharks themselves."

THE singular bulbiform seeds of certain Amaryllideæ—especially species of Amaryllis and Crinum—are the subject of an interesting paper by Dr. A. B. Rendle in the November number of the *Journal of Botany*. These seeds are of three kinds:—(1) True seeds developed from a normal ovule, the outer integument of which becomes thick and fleshy after fertilisation, and forms the substance of the bulbiform mass; (2) true seeds developed from a naked ovule, the fleshy substance being derived entirely from the endosperm, which develops chlorophyll in its outer layers and continues to grow for some time; (3) a vegetative growth replacing the seed; a normal ovule is produced, but a viviparous growth of an adventitious shoot and root takes place at the base, and a bulbil is formed, the ovule integuments forming the outer coats.

DR. FRIEDRICH BERWERTH has communicated to the Vienna Academy of Sciences a paper on soundings from the eastern Mediterranean. In regard to the distribution of calcareous mud, it is found that two principal zones exist, one to the north of the Nile delta, which extends along the Syrian coast and contains but little carbonate of lime (5 to 15 per cent.), while the other, consisting of the remainder of the eastern Mediterranean, is largely calcareous, the proportion of chalky matter being on an average 60 per cent., with variations of 20 per cent. above and below this average. The relation between the proportion of calcareous matter and the depth appears to be at variance with what would be expected from Murray's theory. The sedimentary matter consists, in general, of (1) calcareous organic remains (mollusca and foraminifera), (2) fragments of siliceous matter of organic origin, including sponges and radiolaria, (3) fragments of minerals and rocks, (4) a precipitate, partly calcareous, partly argillaceous, showing little microscopic structure, which constitutes the main part of the mud.

A SOUND and practical knowledge of "The Cyanide Process of Gold Extraction" can be obtained from the volume on that subject by Prof. James Park, published by Messrs. Charles Griffin and Co. The first English edition was favourably noticed in these columns last year (vol. lxii. p. 148), and the second has now appeared. The whole volume has undergone revision, and the new matter includes a detailed description of well-designed slime and sulphide plants now in use in the great mining centres of the world.—Another of Messrs. Griffin's technical handbooks which has reached a second edition is "Practical Coal Mining," by Mr. George L. Kerr, the first edition of which was reviewed in NATURE of February 28 (vol. lxiii. p. 417).

LOW-TEMPERATURE research at the Royal Institution during the past seven years has been assisted by the Hodgkins Trust Fund—a sum of 100,000 dollars left by the late Mr. T. G. Hodgkins as a source of income to be employed in the "investigation of the relations and co-relations existing between man and his Creator." To show what has been done towards this end, Miss Agnes M. Clerke has prepared for the Hodgkins Fund a popular essay on Prof. Dewar's work at the Institution from 1893 to 1900. The essay traces the course of his researches in the physics and chemistry of low temperature, and contains, in addition, three illustrations showing the lecture table of the Royal Institution upon the occasion of the centenary commemoration lecture on liquid hydrogen, and the elaborate refrigerating machinery and liquid hydrogen apparatus used by Prof. Dewar.

THE current number of the *Berichte* contains a paper, by A. Hantzsch and A. Holl, on sulphimide. This substance was first obtained by W. Traube from the products of the action of ammonia upon sulphuryl chloride, and the formula SO_2NH was attributed to it, from the analyses of its salts. In the present paper the authors have been successful in obtaining sulphimide in the solid form, and have found by molecular weight determinations that it resembles cyanuric acid in being trimolecular $(SO_2NH)_3$. They have also succeeded in isolating the methyl ester of this substance, and have found that this is also trimolecular. It is pointed out that the analogy between the nitrogen derivatives of carbonic acid and sulphuric acid is much closer than has hitherto been supposed.

Bulletin No. 186 of the U.S. Geological Survey contains an interesting study of pyrites and marcasite, by Dr. H. N. Stokes, and describes a method for the quantitative determination of these minerals when in mixture. The method depends upon the fact that when either mineral is boiled with an excess of a solution of ferric salt to complete reduction of the latter the ratio of sulphur oxidised to mineral decomposed is perfectly definite and characteristic of each mineral, provided certain standard and easily controllable conditions are observed. Under these conditions the percentage of sulphur oxidised on pyrites is about 60·4 per cent. and on marcasite about 18 per cent. of the total sulphur. The application of this method has thrown considerable light on several doubtful questions relating to the dimorphous FeS_2. It is shown, for example, that density is not a trustworthy means of determining one mineral in presence of the other, that the hypothesis that most natural specimens are mixtures of the two is without foundation, and that there is no evidence of a difference of valency of iron in the two minerals. Specimens crystallising in the regular system are true pyrites, whilst those forming rhombic crystals are true marcasite.

THE additions to the Zoological Society's Gardens during the past week include a White-crowned Mangabey (*Cercocebus aethiops*) from West Africa, presented by Mr. Fred Gordon; a Cape Zorilla (*Ictonyx zorilla*), a Derbian Zonure (*Zonurus giganteus*) from South Africa, presented by Mr. W. L. Sclater; a Gazelle (*Gazella dorcas*) from Egypt, presented by Mrs. Bensusan; a Green Monkey (*Cercopithecus callitrichus*) from West Africa, presented by Mr. John Booth; a Bauer's Parrakeet (*Platycercus zonarius*) from South Australia, presented by Miss Gillam; a Lobed Chameleon (*Chamaeleon parvilobus*) from South Africa, presented by the Rev. Duncan Travers; a Chacma Baboon (*Cynocephalus porcarius*) from South Africa, an Alligator Terrapin (*Chelydra serpentina*), a Pennsylvanian Mud Terrapin (*Cinosternum pennsylvanicum*), a Muhlenberg's Terrapin (*Clemmys muhlenbergi*), six Long-eared Sun Fish (*Leptomis auritus*) from North America, deposited; three Australian Wild Ducks (*Anas superciliosa*), bred in the Gardens.

OUR ASTRONOMICAL COLUMN.

THE LEONID METEORS.—Arrangements are being made at several observatories to record, by eye observations and photography, any Leonid meteors which appear during the epoch of the Leonid meteoric shower, November 14–15.

NEBULOSITY SURROUNDING NOVA PERSEI.—A telegram from the Centralstelle at Kiel announces that from the examination of photographs taken with the Crossley reflector of the Lick

Observatory, Prof. Perrine has found four principal condensations of the faint nebula surrounding Nova Persei, and that these have been displaced *one minute of arc* to the south-east in a period of six weeks.

MEAN PARALLAX OF STARS.—No. 8 of the *Publications* of the Astronomical Laboratory at Groningen contains an investigation, by Prof. J. C. Kapteyn, of the mean parallax of stars considered with reference to their determined proper motions, magnitude and spectral type.

PLANETARY INFLUENCE ON SUN-SPOT PERIOD.—In the Paris *Comptes rendus* (vol. cxxxiii. pp. 726–729), Prof. Birkeland gives the discussion of a further attempt to trace any possible connection between the 11-yearly sun-spot period and the gravitational disturbance of the planets Mercury, Venus and Jupiter, using observations made from 1892–1896. He comes to the same conclusion as formerly, that the variations cannot be traced to planetary influence.

DISTRIBUTION OF COSMIC VELOCITIES.—Profs. J. C. Kapteyn and W. Kapteyn have recently completed the elaborate treatment of two preliminary communications made by the former to the Academy of Sciences at Amsterdam, and the first part of the treatise is published as No. 5 of the *Publications of the Astronomical Laboratory of Groningen*.

In this an attempt is made to deduce, from the available observations of proper motion, the law defining the relation between the number of stars having linear velocities of determined values, or shorter, the law by which the frequency of a linear velocity is given as a function of its magnitude. The main assumption on which the derivation is based is "the real motions of the stars are equally frequent in all directions."

In the papers mentioned above it had been stated that certain inequalities existed in the distribution of velocities with respect to the apex of the solar motion, and that these had been traced to the influence of a systematic error of the proper motions in declination. It is now thought that many of the former difficulties will be removed by the introduction of a correction for this anomaly.

The formulæ given are developed to such terms as are likely to provide for any great future extension of the accuracy attainable in proper motion determinations, and although the time may come when spectroscopic investigations of velocity (the accuracy of which does not depend on the distances) will supersede the present observations, at present the possibility of having two independent determinations from different components of the real motion is a valuable and important consideration.

The second part of the work, dealing with the application of these formulæ to the observations, will be presented in a later publication.

THE INFLUENCE OF THE MEDITERRANEAN PEOPLES IN PREHISTORIC BRITAIN.[1]

THE progress of archæological discovery during the last twenty years has thrown a flood of light on the relation of the prehistoric period in Europe north of the Alps to the civilisation of the Mediterranean in the period embraced by history. We are now in a position to recognise the source from which the inhabitants of middle and northern Europe, and of the British Isles, obtained the art manifested in their articles of daily use, and we are able to trace them back to that wonderful Mediterranean civilisation, proved by the labours of Schliemann to be older than the Greeks and shown recently by Mr. Arthur Evans to have occupied a commanding position in the island of Crete. Schliemann discovered its range over the eastern Mediterranean from Troy to the Peloponnese, Evans extends it to almost within sight of Italy, where the Etruscan civilisation is the dominant factor at the dawn of history.

The picture presented to us of the Mediterranean region during the period extending from the establishment of the Greeks in the east and the Romans in the west, backwards to at least 2300 years B.C., as proved by the discoveries at Knôssos, may be outlined as follows. A civilisation of the very highest order existed in the region extending from Italy eastwards through the Ægean Sea to Asia Minor, equal in splendour to that of Egypt and Assyria. Although it borrowed many things from both, it was a development independent of both, and, so far as the evidence goes, it appears to have been indigenous in the Mediterranean region and Asia Minor. Whether or no it is as ancient as that of Egypt and Assyria is an open question.[1] It was common to the ancient Trojans and Mycenæans overthrown by the Greeks, to the Cretans, and to the Etruscans overthrown by the Romans. It is worthy of remark that in the eastern Mediterranean it formed the foundation of Greek art, while it survived in the west under the name of Roman, its possessors in each case being absorbed into the Greek and Roman peoples.

The establishment of the Phœnicians in the Eastern Mediterranean, at least as far back as the seventeenth century B.C., as proved in the records of Egypt, has also to be considered. They were the great merchants and carriers, distributing the wares of Egypt, and later of Assyria, to the various Mediterranean peoples, founding colonies here and there, among the greatest of which was Gades (Cadiz), about 1100 B.C., and Carthage, 814 B.C. Their fleets in penetrating westward had to contend with the Etruscan maritime power, dominant in the western Mediterranean. They and the Etruscans were the great distributors of metal, more particularly bronze, and their ships penetrated in later times far northwards along the Atlantic shore. It is not at all improbable that Phœnician ships coasted along the Atlantic as far north as the British Isles, bringing with them the wares of the Mediterranean and returning with tin from Cornwall and gold from Ireland. There is, however, no absolute proof of their presence in Britain, because, like the English of to-day, they had no art of their own and merely imitated the art of other peoples.

During the period under consideration, the various peoples inhabiting the Mediterranean were sufficiently organised to allow of a confederacy for the attack of Egypt. The first mention of a European people in the Egyptian annals is the attack of the Sardones and the Tyrrhenes (Etruscans) and their defeat by Ramses II. in the seventeenth century B.C. This was followed about seventy years afterwards by a more formidable combination, in which the two above-mentioned peoples were joined by the Sicels, Lycians, Achæans and Lybians. The allies advanced by sea and land, conquered part of the Delta, and were defeated after a desperate struggle by Meneptah I.

It remains now to trace the influence of the Mediterranean civilisation through middle and northern Europe. The two oldest routes of traffic are those starting from the head of the Adriatic, from the ancient Etruscan city of Hatria. The first runs by Trieste, Laibach, Gratz and Bruck, to Presburg, and thence past Breslau and along the Lower Vistula to the amber coast of Samland. The second, or western route, takes the line of the Adige, past Verona and Trient, over the Brenner Pass into the valley of the Inn, crossing the Danube either at Linz or Passau. Thence it ran through the Bohemian passes into the valley of the Elbe, and made for the amber coast of Schleswig and Holstein. These were the two principal routes taken by the caravans, which brought to the inhabitants of middle and northern Europe in the Bronze Age bronze swords, axes, daggers, bracelets, brooches and other articles from the south, carrying back, among other things, the amber so highly valued by the Mediterranean peoples. There were probably similar routes to these northwards and westwards over the plains of France, starting from the Alpine passes, and along the river valleys, along the lines afterwards followed by the Greeks of Marseilles (Massilia). It was probably by one or other of these routes that brooches, swords and other implements of southern derivation, arrived at the sea-board of the North Sea and Atlantic, and were brought by ship into Britain and Ireland. Ireland, it must be noted, at this time was the *El Dorado* of the west, attracting adventurers from the south both by sea and land.

These routes were also used in the prehistoric Iron Age north of the Alps, and along them metal work of most beautiful design, brooches and bracelets, mirrors and other articles, belonging to the so-called "late Celtic" art, were introduced into Britain—such, for example, as the mirror, brooch, and bronze bowl found at Glastonbury. In Ireland this art is amply represented in the numerous golden and bronze ornaments.

The Greeks, too, after their establishment at Massilia in the sixth century B.C., took up this trade, making clearly defined routes through France, to the Atlantic shore and to the Rhine valley, along which the tin of Cornwall was carried overland to

[1] Presidential Address by Prof. Boyd Dawkins, D.Sc., F.R.S., to the Vesey Club, on October 15, illustrated with slides.

[1] I feel unable to accept Prof. Flinders Petrie's conclusion, that some of the pottery found in the tombs of the first dynasty in Egypt belongs to the Mycenæan or Ægean pottery, and therefore goes back as far as 4750 B.C.

the south. They also probably carried on a trade by sea. In 325 B.C., Pythias, the first explorer of Britain known to fame, was sent at the head of an expedition from Massilia, working his way along the Atlantic coast and wintering somewhere near Dover. From this point he sailed to the Orkneys and Scandinavia, returning by way of the amber coast at the mouth of the Elbe. The Greek influence was also felt from the northern borders of Greece through Germany. In Britain a coinage which was copied from the Stater of Philip of Macedon marks the close of the prehistoric Iron Age, when the Greek influence was dominant. In Ireland, it is worthy of note, none of these coins have been met with, and it is likely, therefore, that the Greek influence was never felt in that island.

From this outline it is clear that the principal artistic development in Britain, in the Bronze and prehistoric Iron Ages, was due to the art of the south, and that it was derived mainly from the Mediterranean civilisation, including under that term Mycenæan, Ægean, Etruscan and Dalmatian art, and that in later times it was aided by intercourse with the Greeks.

W. BOYD DAWKINS.

THE MOVEMENTS OF PLANTS.[1]

IT is sometimes asserted that the power of movement is a character distinguishing animals from plants. This statement arises to some extent from an obvious confusion of thought. Trees are stationary, they are rooted to one spot; but they are not, therefore, motionless. We think them so because our eyes are dull—a fault curable with the help of a microscope. And when we get into the land of magnification, where the little looks big and the slow looks quick, we see such evidence of movement that we wonder we do not hear as well as see the stream of life that flows before our eyes.

In speaking of the cells of which plants are built, Mr. Huxley said that a plant is "an animal enclosed in a wooden box, and Nature, like Sycorax, holds thousands of delicate Ariels imprisoned in every oak." It is this delicate prisoner, the living protoplasm, that we may watch pacing round its prison walls. And we may see it stop as though frightened at our rough usage, and then, after a hesitating twitch or two, we see it recover and once more flow round the cell. Or we can see under the microscope minute free-swimming plants rushing across the field of view, all one way, like a flock of little green sheep that we can drive to and fro with a ray of light for a sheep dog.

But I am not going to speak to-night of microscopic matters, but rather of things on a bigger scale which can be seen with the naked eye. I will begin by trying to show that very obvious movements are to be seen in every kitchen garden or in every garret window where a scarlet runner is grown for its red flowers' sake.

If you will examine a scarlet runner, you see that the shoot is not completely vertical, but bends over to one side. To record the movements of the plant a series of photographs may be taken vertically from above the plant, so that the end of the shoot shows like the hand of a watch against a sort of clock-face on which the points of the compass are marked. These photographs will show how the shoot swings round in its instinctive search for another stick to climb up.

This well-known movement is performed by a co-ordinated series of curvatures the exact nature of which need not trouble us now. Let us rather consider the less obvious power of coordination which enables a plant to grow upwards in a straight line. Think of a forest of pine trees, hundreds of thousands of them, all growing vertically up towards the sky. Here is a clear case of movement, for the leading shoots were once but a few inches from the ground, and now they are crawling along vertical lines 100 feet up in the air. It may be said that this is mere increase in size, not movement in the ordinary sense. But I can show you that the trees could not grow in this way had they not a power of curvature to which the name of movement cannot be refused.

As it is not easy to experiment on pine trees, we will use a pot of mustard seedlings, which represents in miniature a forest of vertical stems. Now suppose the flower-pot upset and left lying on its side for a few hours: the seedlings will be found to have all recovered the vertical position, and they have done so by a bend which is just as much a case of movement as the flexure of a man's arm, though it is effected by a very different mechanism. Not everyone realises how rapid this movement is. Fig. 1 is from a diagram made in the ordinary course of class-work at Cambridge, and illustrates this point. A shoot of *Valerian* was placed horizontally at 2.17 and a black line painted like a silhouette on a vertical sheet of glass to record its position at 2.30; similar lines were painted at intervals, forming a record of fairly rapid movement. If greater delicacy of observation had been practised, it would have been easy to show that the plant begins to curve up within a few minutes of being placed horizontally.

It is a remarkable fact that the plant should be stimulated, or stirred up, to a definite curvature by merely placing it horizontally. The curvature tends to bring the plant into the upright position, and when the whole stem has reached the vertical, the stimulus ceases to exist. It is as though the plant were in a condition of content when vertical and of discontent in any other position, and as though the discontent expressed itself in curvature.

But the plant does not gain the vertical by a single continuous curvature; at first it overdoes the thing (see Fig. 1) and the end of the shoot may pass beyond the vertical by 20°–30°. But this new position, inasmuch as it is not vertical, originates a new stimulus, and the new curvature which follows brings the shoot back towards the upright position. It may again overshoot the mark, but by repeated corrections it finally attains the normal upright posture.

It is this power of correcting the line of growth whenever it deviates from the upright that enables the pine tree to grow

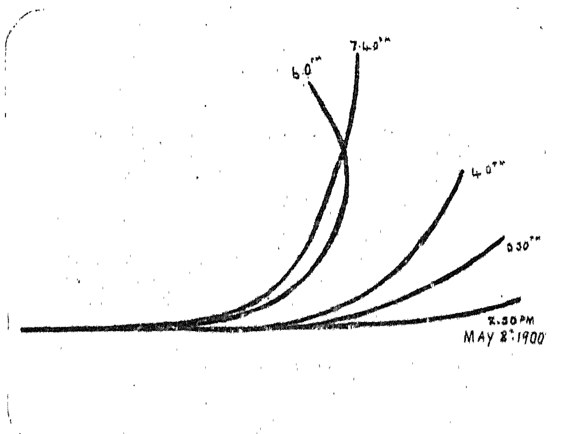

FIG. 1.—A *Valerian* stem curving geotropically.

straight upwards. And this is what I meant when I said that its habit of growth depends on regulated curvature to which no one can refuse the name of movement.

The pine and the seedling have, in fact, a wonderful kind of sensitiveness—a sensitiveness to the force of gravity. To those accustomed to think of Mimosa as the sensitive plant *par excellence* my words may sound strange. But the sensitiveness of Mimosa is crude by comparison with that of the seedling. A plant with a perception of the position of the centre of the earth and a power of growing along the line so perceived is a much greater miracle than a leaf that closes its leaflets when burnt or cut or shaken.

I hope I shall be able to prove to you that we can point to certain parts of the plant which have the special quality of the perception of gravitation, but we are at present ignorant of how the act of perception is effected. We know something of the machinery of hearing or vision in animals, but in plants we can only guess that when a cell is placed horizontally a resulting change of pressure on the protoplasm produces that loss of equilibrium which is translated into curvature.[1]

The use of this gravitational sensitiveness is clear enough. It is to the pine tree what a plumb-line is to the builder, for

[1] Evening lecture delivered at the Glasgow meeting of the British Association, September 16, by Francis Darwin, F.R.S.

[1] It is, however, probable that Nemec and Haberlandt are right, and that the stimulus depends on the pressure of solid particles, *e.g.* starch-grains, on the protoplasm. See their papers in the *Deutsch Bot. Ges.*, 1900.

neither plant nor man can build high unless he builds straight. A man has a general perception of the verticalness of his body and of surrounding objects, but he does not trust to this sense in placing brick on brick to make a house. He uses a plumb-line which tells him through his eye the precise line along which he must pile his bricks. The tree has also to pile one over another the cells or chambers in which its protoplasmic body lives, and this too must be done along a vertical line; but the plant does it by the sensitiveness to gravity of which I have spoken.

It must be clearly understood that gravity does not act directly on the growth of plants. It does not act as a magnet acts on iron, or to take a better example, it does not simply act as gravity acts on the plumb-line in which the string is kept in a vertical straight line by the weight. It might be supposed that in some occult way the stem was mechanically kept straight like the string, and this indeed was the view formerly held about such roots as grow straight down into the earth. But it is not so; the thing is not explicable mechanically. Gravitation is nothing more than a sign-post or signal to the plant—a signal which the plant interprets in the way best suited to its success in the struggle for life, just as what we see or hear gives us signals of the changes in the exterior world by which we regulate our conduct.

You will say that this is hard to prove, and indeed, like other biological hypotheses, it can only be shown to be true by explaining a number of facts. It is interesting to try to explain the facts without the assumption in question. If gravity does *not* act indirectly as a signal it must act directly, and we must find a reason why, in the case of the mustard seedling above referred to, the stem has grown up and the root down. There is absolutely nothing in their structure or manner of growth to help us to see why this difference of behaviour under identical conditions should exist. And if, instead of placing the mustard seedling in the dark we had grown it near the window, we should have come across another remarkable phenomenon, namely, that the stem grows towards, the root away from, the light—and this is equally inexplicable on a mechanical basis.

But it may be said that it is not fair to compare a root and a stem which are structurally unlike. Let us, therefore, stick to roots. When the root of a bean has grown vertically down into the soil for some distance it begins to bud forth into side roots. These are exactly like the primary root from which they spring; there is no difference in structure or in machinery of growth. Yet the secondary roots do not grow vertically down, but obliquely, or in some cases horizontally. There is one more striking fact about the roots of the bean. The secondary, like the primary roots, give off branches, and these—the tertiaries—behave differently from both primary and secondary roots. For instead of directing themselves vertically or horizontally, they simply treat the force of gravity with contempt and grow just where fancy leads them. The point on which I wish to insist is that it is impossible to explain on any theory of the direct action of gravity why the three orders of roots have three distinct modes of growth. They may remind us of three generations, grandfather, father, and son, all of one blood and yet behaving towards the universe in three distinct ways—a fact not unknown in human society.

On the other hand, it would not be difficult to show that the behaviour of the three orders of roots is well suited to the plant's needs, and therefore we can understand how the power of behaving in three different ways to the same signal has been evolved. The main root takes the shortest course to the deeper layers of earth; the four or five ranks of secondary roots divide the world between them and push forth all round, keeping slightly below the horizontal; the tertiaries take it for granted that their predecessors have done the usual thing and that they can satisfactorily occupy the spaces left among their elders by random growth. The fact that the tertiary roots have no specialised sensitiveness of gravitation shows that their unregulated growth is good enough for the necessities of the case. For among organised beings necessity is the mother of development, and what their brethren of second rank have developed they too could assuredly have gained. To this point of view I shall return, but first I should like to give a few more instances of actions carried out in response to the signal of gravity; and these examples shall be from stem-structures.

The flower-heads of a clover (*T. subterraneum*) bury themselves in the ground, thus effectually sowing their own seeds, and they are guided to the ground by their unusual capacity of curving down and directing themselves like a primary root towards the centre of the earth.

Other flower-stalks are guided by gravitation for quite different purposes. Take, for instance, a common narcissus. In the young condition there is a straight shaft piercing the ground

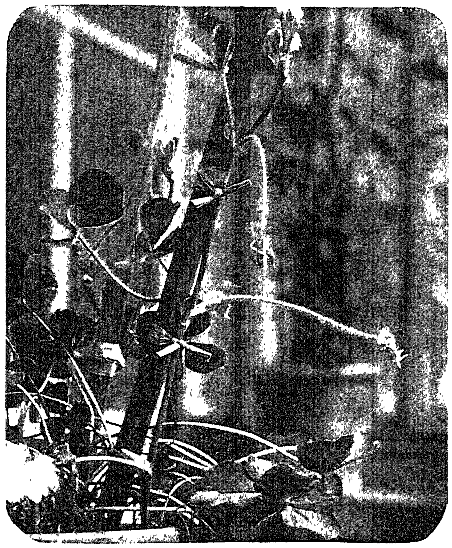

FIG. 2.—*Trifolium subterraneum*. Two flower-heads in the fruiting condition: the upper one has bent sharply and is growing vertically downwards.

with its compact pointed flower bud; but as the flower opens the stalk bends close to the top and brings the flower-tube into a roughly horizontal position, where it shows off its brightly coloured crown to the insects that visit it. The flowers are guided to the right position by the gravitation sense, and they increase or diminish the angular bend in their stalk till the right position is attained, as shown in Fig. 3. The same thing

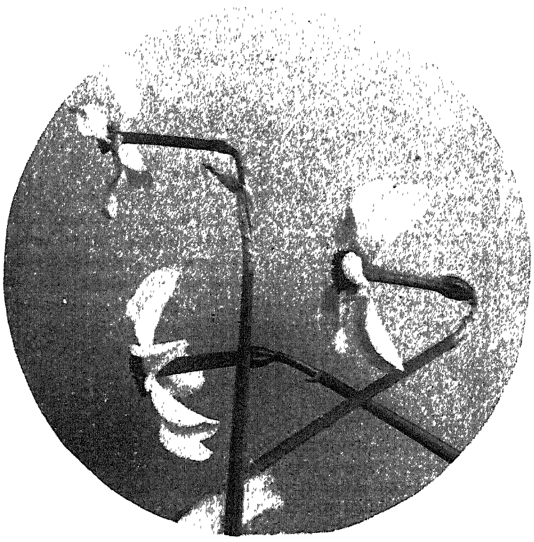

FIG. 3.—Narcissus flowers.

may be easily seen in the larkspur. So long as the plant is left to itself the flower-stalk remains quiescent, but if the stem is displaced so that the flower makes the wrong angle with the vertical, the stalk is stimulated to curve, and bends until the flower is once more in its proper position.

All these cases of plants executing certain useful curvatures

which occur when the plant is displaced as regards the vertical and cease when the habitual relation is reached, all these, I say, seem to me only explicable on the theory that gravitation does not act as a mechanical influence, but as a signal which the plant may neglect entirely, or, if it notices, may interpret in any way; that is, it may grow along the indicated line in either direction or across it at any angle. You may say that this is no explanation at all, that it only amounts to saying that the plant can do as it chooses. I have no objection to this, if you will first define the meaning of the word "choice."

I AM now going to deal with the subject of movement from a somewhat different point of view, namely, to show that it is possible to discover the part of the plant which reads the signal, and this is not necessarily the part that executes the correlated movement. In the reflex movement of an animal (for instance, a cough produced by a crumb going the wrong way), we distinguish the irritation of the throat and the violent action of the muscles of the chest and abdomen, and further, the nervous machinery by which the stimulus is reflected or switched on, by way of the central nervous system, from throat to coughing muscles. In the plant, too, if we are to compare its movements to the reflexes of animals (as has been done by Czapek), we must distinguish a region of percipience, another of motility, and the transmission of an influence from the percipient to the motor region.

Transmission of a stimulus has long been known in Mimosa, but in the far more important curvatures which we are now considering it was not known to exist before the publication of the "Power of Movement in Plants." There is an experiment of Rothert's[1] which we do in class work at Cambridge, and which only differs from my father's classical experiment in the fact that a much more perfectly adapted plant is employed. The plant in question is a grass, *Setaria*, which has a remarkable form of seedling. When the grain germinates it does not send up a simple cylindrical sprout like an oat, but a delicate stem terminating in a pointed swollen part which looks like a little spear-head. When a group of *Setarias* is illuminated from one side, they bend strongly over, with their little spear-heads all pointing straight at the light. The spear-heads do not bend; the whole movement is carried out by the stalk on which the head is supported. But the remarkable thing is that it is the spear-head and not the stalk which perceives the light. This is easily proved by covering the heads of a few *Setarias* with opaque caps. For the result is that the blindfolded seedlings remain vertical while their companions are pointing to the light. Thus the part which bends is unaffected by illumination, and the part which is affected does not bend. The spear-head is the percipient organ, the shaft or stalk is the motor region, and from head to shaft an influence has clearly been transmitted.

My father and I made an attempt to prove the same thing for the gravitation-sense of roots, that is, to prove that the tip of the root is the region in which the force of gravity is perceived by the plant. Our method of proof does not hold good, but our conclusions are true after all. When gravitation is the stimulus, the experiment is much more difficult than when light is in question, because now that fairy godmothers are extinct we must not hope for a substance opaque to gravitation, a substance with which we might shelter the root-tips from the force of gravity as the tips of the *Setaria* seedlings were sheltered from light.

The plan adopted by us was simply to cut off the extreme tip of the roots, and fortunately (or unfortunately) the result was just what was expected—the tipless roots had lost the sense of gravitation and were unable to curve downwards towards the centre of the earth. It was surely natural to believe that the tipless roots failed to bend because their sense-organs—their percipient parts—had been removed. As a matter of fact they had been removed, but it was fairly objected that the operation of removing the delicate tissues at the tip of the root is a severe one, and that the roots which refused to grow downwards were suffering from shock and not from the absence of their sense-organs.

The subsequent history of the inquiry is an instance of the unwisdom of prophesying unless you know. In 1894 an able summary of the question was published in a German journal, in which the impossibility of solving the problem of the gravitational sensitiveness of the root-tip was dwelt on, and immediately afterwards Section K of this Association had the satisfaction of hearing Pfeffer read a brilliant paper giving the long-hoped-for proof that the tip of the root is a sense-organ for gravitation.[1]

Like many other experiments, it depends on a deception or trick played on the plant. The root is forced to grow into a glass tube closed at one end and sharply bent in the middle, resembling, in fact, a little glass boot. The extreme tip is thus kept at right angles to the main body of the root; if the theory we are testing is the right one, a root with its motor region horizontal and its tip vertical ought to continue to grow horizontally, because the tip being vertical is not stimulated by gravity; it is in a quiescent, or, as it were, a satisfied condition, and no bending influence is being sent to the motor region. And this is what Pfeffer and Czapek found. Fig. 4 A, if turned through a right angle, will represent such a root. On the other hand, if the main body of the root points vertically down while the sensitive tip is horizontal, a curvature results, because as long as the tip is horizontal it is stimulated, and the stimulus is transmitted to the motor region. Fig. 4 A shows the tip horizontal; B shows the curvature which brings the tip into the vertical once more.

This experiment proves not only that the tip of the root is the sense-organ for gravity, but also that the motile part is not directly sensitive; in other words, that gravitation is perceived exclusively in the tip of the root. Since the publication of Pfeffer's and Czapek's papers I have been lucky enough to hit on another way of testing the theory that the tip is the percipient organ for gravitation,[2] and I am not without hopes that botanists may become in this question as fertile as Cyrano with his seven ways of flying to the moon.

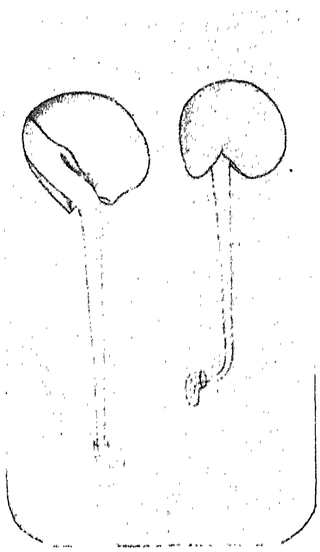

FIG. 4.—Roots in glass boots (from *Pringsheim's Jahrbücher*).

There is a certain kind of inverted action familiarly known as the tail wagging the dog, and it is on this principle of inversion that my experiment is designed. Inversion may in some cases be practised without altering the final result. For instance, it does not much matter whether the thread goes to the needle (the rational masculine plan) or *vice versâ*, as in the orthodox feminine way of threading a needle. In other cases you create what is practically a new machine by inversion, as in a certain apparatus in which the hand of a clock stops still while the clock itself rotates. The effect is still more striking with my plants, for the inversion practised on them entirely changes the character of their movement.

The result may be shown with the seedling *Setarias* of

[1] Cohn's *Beiträge*, 1894.

[1] Pfeffer, in the *Annals of Botany*, September 1894. Further details in Czapek's paper in *Pringsheim's Jahrb.*, 1895.

[2] F. Darwin, *Annals of Botany*, December, 1899.

which I have spoken, or with *Sorghum*, as in Fig. 5. If one of these is supported by its seed with its stem projecting freely in the horizontal plane, the gravitation stimulus makes it bend upwards until the tip is vertical, when the stimulus ceases to act and the curvature comes to an end. If the conditions are reversed, if the seedling is supported in a horizontal position *by its tip*, while the seed projects freely, the result is at first the same, though finally it comes to be strikingly

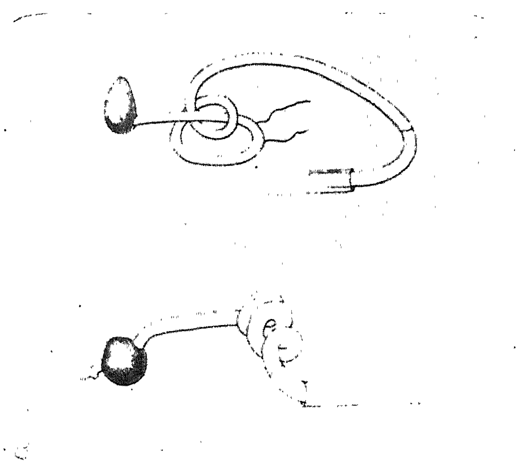

FIG. 5.—Seedling *Sorghums* supported by their tips in horizontal glass tubes. (From the *Annals of Botany*.)

different. The basal end of the seedling is carried upwards by the curvature of the stem; but according to the theory we are testing, the tip of the seedling is the only part of the plant which feels the gravitational stimulus, and the tip of the seedling remains horizontal in spite of the curvature of the stem. Therefore the tip of the seedling is not freed from stimulation as it was in the first case, where the curvature brought the tip into

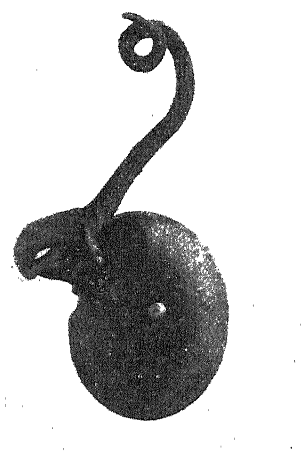

FIG. 6.—A bean-root which had been supported by the tip; the curvature thus corresponds to that in Fig. 5.

the vertical position. The horizontal tip therefore continues to send commands to the stem to go on curving, in a way I can best explain if I am allowed to make the plant express its sensations in words. The tip says to the stem, "I am horizontal, therefore you must bend upwards"; and when this order has been obeyed the tip says, "It is of no use, I am still horizontal—go on bending." The result is that the stem curls up into a spiral like a corkscrew or a French horn, as shown in Fig. 5. I have also been able to get the same result with the roots of beans and peas, as shown in Fig 6.[1]

These unfortunate plants are in the position of a convict on the treadmill; their movements are, from their own point of view, absolutely ineffectual and meaningless. The results are, however, of some importance from our point of view, since they give clear support to the theory which I have now attempted to place before you, namely, that the percipient region is at the tip of the *Setaria* seedling or of the bean root (as the case may be), and that by what corresponds to a reflex action the stimulus perceived by the tip is transmitted to the motor region. I think I may quote my father's words and say that it is hardly an exaggeration to say that the tip acts like the brain of one of the lower animals.

I should like to add a few words on the question how far the movement of plants can be placed under the general laws deducible for the movements of animals. Unfortunately, as soon as we attack this question we are liable to enter regions where for the ignorant there are many pitfalls. We are, in fact, face to face with the question whether in plants there is anything in which we may recognise the faint beginnings of consciousness, whether plants have the rudiments of desire or of memory, or other qualities generally described as mental.

If we take the wide view of memory which has been set forth by Mr. S. Butler[2] and by Prof. Hering, we shall be forced to believe that plants, like all other living things, have a kind of memory. For these writers make memory cover the whole phenomena of life. Inheritance with them is a form of memory, or memory a kind of inheritance. A plant or an animal grows into the form inherited from its ancestors by passing through a series of changes, each change being linked to the preceding stage as the notes of a tune are linked together in the nervous system of one who plays the piano. Or we may compare the development of an animal or plant to the firing of a train of gunpowder, which completes itself by a series of explosions each leading to a new one. To use the language I have been employing, each stage in development acts as a signal to the next.

In the same way the characteristic element in what is done by memory or by that "unconscious memory"[3] known as habit is the association of a chain of thoughts or actions each calling forth the next.

What I wish to insist on is that the process I have called action by signal is of the same type as action by association, and therefore allied to habit and memory. The plants alive to-day are the successful ones who have inherited from successful ancestors the power of curving in certain ways when, by accidental deviations from their normal attitude, some change of pressure is produced in their protoplasm. With the pianist the playing of A has become tied to, entangled or associated with the playing of B, so that the playing of A has grown to be a signal to the muscles to play B: similarly in the plant the act of bending has become tied to, entangled or associated with, that change in the protoplasm due to the altered position. There is no mechanical necessity that B should follow A in the tune; the sequence is owing to the path built by habit in the man's brain. And this is equally true of the plant, in which a hereditary habit has been built up in a brain-like root-tip.

The capacities of plants of which I have spoken have been compared to instincts, and if I prefer to call them reflexes it is because instinct is generally applied to actions with something of an undoubted mental basis. I do not necessarily wish it to be inferred that there can be nothing in plants which may possibly be construed as the germ of consciousness—nothing psychic, to use a convenient term; but it is clearly our duty to explain the facts, if possible, without assuming a psychological resemblance between plants and human beings, lest we go astray into anthropomorphism or sentimentality, and sin against the law of parsimony, which forbids us to assume the action of higher causes when lower will suffice.

The problem is clearly one for treatment by evolutionary method—for instance, by applying the principle of continuity.[4] Man is developed from an ovum, and since man has consciousness it is allowable to suppose that the speck of protoplasm from which he develops has a quality which can grow into consciousness, and by analogy that other protoplasmic bodies, for instance those found in plants, have at least the ghosts of similar

[1] F. Darwin, in *Proc.* Cambridge Phil. Soc., xi.
[2] "Life and Habit," 1878.
[3] Mr. S. Butler's term.
[4] See James Ward, "Naturalism and Agnosticism," i. 283.

qualities. But the principle of continuity may be used the other way up—it may be argued that if a lump of protoplasm can perform the essential functions of a living thing to all appearances without consciousness, the supposed value of consciousness in Man is an illusion. This is the doctrine of animal automatism so brilliantly treated by Mr. Huxley.[1] He is chiefly concerned with the value of consciousness to an organism—a question into which I cannot enter. What concerns us now is that, however we use the doctrine of continuity, it gives support to belief in a psychic element in plants. All I contend for at this moment is that there is nothing unscientific in classing animals and plants together from a psychological standpoint. For this contention I may quote a well-known psychologist, Dr. James Ward,[2] who concludes that mind "is always implicated in life." He remarks, too (*ibid.* p. 287), "it would be hardly going too far to say that Aristotle's conception of a plant-soul . . . . is tenable even to-day, at least as tenable as any such notion can be at a time when souls are out of fashion."

This is a path of inquiry I am quite incapable of pursuing. It would be safer for me to rest contented with asserting that plants are vegetable automata, as some philosophers are content to make an automaton of Man. But I am not satisfied with this resting-place. And I hope that other biologists will not be satisfied with a point of view in which consciousness is no more than a bye-product of automatic action, and that they will in time gain a definite conception of the value of consciousness in the economy of living organisms. Nor can I doubt that the facts we have to-night discussed must contribute to the foundation of this wider psychological outlook.

LESSONS FROM GERMANY.

WE are glad to see that many public men are directing attention to the relationship between scientific investigation and industrial progress, and urging reforms which were advocated in these columns, and by men of science generally, long before the present position was reached. There is no question now that resolute efforts must be made if Great Britain is to hold her own during the twentieth century. Already we have lost supremacy in several branches of industry, and we shall probably be surpassed in others by America and Germany unless our commercial men learn to realise that science is the source of energy of all sustained industrial movements.

It is the business of scientific research to extend natural knowledge, and the investigator is not usually concerned with the commercial aspects of his work. The application of scientific results to industrial developments is for the manufacturer and merchant to consider, but they are unable to appreciate the possibilities of such results unless they have themselves had a scientific education. A discovery which to one man appears trivial may be made by another the nucleus of a great industrial development. Commercial history can afford numerous instances of the connection between science and prescience and the influence which the two combined exert upon progress. Mr. R. B. Haldane, M.P., mentions a few cases of this kind in an article in the November number of the *Monthly Review.* He selects the brewing industry as one instance of a change which should cause national concern. Thirty years ago Germany exported no beer, to-day she exports almost as much as Britain. The advance is due to the discovery and application of scientific method. When the "Brauerbund" was formed, it was definitely decided to make science with practice and practice with science the principle to work upon. Scientific stations were established in which technical problems confronting the practical brewer could be studied, brewing schools were founded, each with laboratories, experimental maltings and a brewery attached to them, and every effort was made to provide for the education of brewers with scientific as well as technical knowledge. The result of this thorough provision for educating scientific brewers is that German beer is a very active rival of English beers in our own country, and in France it almost monopolises the market.

This is one example given by Mr. Haldane to show how the industrial life in Germany is in close contact with the academic life. The case of the aniline dyes is too well known to need to be described here again, but our loss may be understood by the fact that 80 per cent. of the coal-tar colours used by the Bradford Dyers' Association now comes from Germany.

[1] "Science and Culture," Collected Essays, i.
[2] *Loc. cit.* p. 288.

It is, however, not only through the school that the man of science in Germany comes to the aid of industry, but also through the experiment stations or central bureaus of scientific opinion. The German, remarks Mr. Haldane, "is aware of the enormous extent to which he is dependent upon high science, and, further, that the best high science cannot be bought by the private firm or company. Accordingly the rival German explosives manufacturers several years ago combined to subscribe about 100,000*l.* and to found close to Berlin what they call their Central-Stelle. This establishment, which is maintained by subscription at a cost of about 12,000*l.* a year, is presided over by one of the most distinguished professors of chemistry in the University of that city, with a staff of highly-trained assistants. To it are referred as they arise the problems (in this industry these abound) by which the subscribers in their individual work are confronted. By it is carried on a regular system of research in the field of production of explosives, the fruits of which are communicated to the subscribers."

Compare this organised system of determining the best methods and processes with the narrow spirit in which most of our commercial work is carried on. Trade rivalry exists in Germany as much as here, but it does not prevent combination having for its object the scientific study of subjects related to industries and manufactures.

The universities, technical schools and other academic institutions are all part of an organised system, and though the aim is culture, the application of the highest knowledge to commercial enterprise is borne in mind, and everything is done to encourage it. It is not necessary for us to copy Germany in everything, but we need more of the spirit which has built up such a splendid system of study and brought science, education and industry into such close relationship. It is the duty of the State to do far more than it has hitherto done to promote this connection by assisting research, organising and extending scientific education, and encouraging men to devote their lives to the extension of natural knowledge.

THE BICENTENNIAL OF YALE UNIVERSITY.

THE two hundredth anniversary of the foundation of the University was celebrated by a series of imposing ceremonies at the end of last month. Representatives were present from many universities and colleges, and addresses of congratulation upon the past performances and future promise of Yale were read.

The following is the address written by the Public Orator, Dr. Sandys, and presented to Yale University by the delegates appointed to represent the University of Cambridge at the recent celebration. The delegates appointed were Sir Robert Ball, Fellow of King's and Lowndean professor of astronomy, the Hon. W. Everett, formerly of Trinity College (author of lectures "On the Cam," delivered in Boston, 1865), and Mr. John Cox, late Fellow of Trinity, professor of physics at Montreal. Sir Robert Ball was unavoidably prevented from attending the celebration.

"Litteris vestris, viri nomine non uno nobis coniunctissimi, trans oceanum Atlanticum ad nos nuper perlatis libenter intelleximus, Universitatem vestram, inter Musarum sedes transmarinas prope omnium vetustissimam, annis iam ducentis ab origine sua feliciter exactis, sacra saecularia paucos post menses esse celebraturam. Trans oceanum illum, non iam ut olim dissociabilem, plus quam sexaginta (ut accepimus) ante originem vestram annis, Insulae Longae e regione, Fluminis Longi inter ripas, Britannorum coloni Portum Novum invenerunt, ubi postea Collegio vestro antiquo nomine novo indito civis Londiniensis liberalitatem etiam illustriorem effecistis. Ergo et animi nostri fraterni in testimonium, et diei tam fausti in honorem, tres viros amicitiae foederi novo vobiscum feriundo libenter delegimus, primum Astronomiae professorem nostrum facundum, quem quasi nuntium nostrum sidereum, velut alterum Mercurium Pleiadis filium Atlantis nepotem, trans maria ad vos mittimus; deinde, e vestra orbis terrarum parte, non modo Universitatis Cantabrigiensis utriusque alumnum, cuius eloquentia olim Cami nostri nomen Angliae Novae inter cives magis notum reddidit, sed etiam Universitatis nostrae alumnum alterum, qui provinciae Canadensis Universitatum inter professores numeratur. Has igitur litteras a legatione nostra ad vos perferendas Mercurio nostro tradimus, in quibus Universitati vestrae florentissimae propterea praesertim gratulamur, quod

nuper tam insigne vivacitatis documentum dedistis, ut ex alumnis vestris, quos quindecim milium ad numerum per annos ducentos laurea vestra coronastis, partem plus quam dimidiam adhuc inter vivos numerare potueritis. Valete atque etiam in posterum plurimos per annos felices vivite."

The doctorate of laws was conferred on President Roosevelt and forty-six others, including the following men of science and college presidents:—Prof. J. H. Biles (Glasgow), Dr. J. S. Billings (New York), President C. W. Dabney (Tennessee), Prof. D. W. Finlay (Aberdeen), Prof. Jacques Hadamard (Paris), Dr. S. P. Langley (Smithsonian Institution), Prof. A. A. Michelson (Chicago), Prof. W. Osler (Baltimore), President H. S. Pritchett (Massachusetts), President Ira Remsen (Baltimore), Prof. O. N. Rood (Columbia University), Prof. Wilhelm Waldeyer (Berlin), President J. B. Angell (Michigan), Principal William Peterson (McGill University), Mr. Seth Low (ex-president of Columbia University), President J. G. Schurman (Cornell), Mr. Franklin Carter (ex-president of Williams College), President W. R. Harper (Chicago), Mr. W. C. Harrison (Pennsylvania), President F. L. Patton (Princeton), President B. I. Wheeler (University of California).

On October 22, Dr. D. C. Gilman, a graduate of Yale, and for twenty-five years president of the Johns Hopkins University, delivered an address on the relations of Yale University to letters and science. The address is published in full in *Science* of November 1, from which we select a few notes on men of science who have been connected with Yale.

The Collegiate School of Connecticut was the beginning of Yale University; it became Yale College in 1718, and about the beginning of the nineteenth century developed into the University. During the last fifty years two new schools have sprung into existence—the Sheffield Scientific School and the School of Fine Arts—and the former has increased in importance in a most remarkable manner.

Prior to the Revolution the two men of more than provincial fame whose names are associated with Yale are Edwards, the naturalist, and Eliot. Before Yale College was fifty years old, Benjamin Franklin became its valued friend and was enrolled among its laureati in 1753. Four years previously he had presented the College with an electrical machine which enabled the young tutor, Ezra Stiles, to perform the first electrical experiments tried in New England. A Fahrenheit thermometer was a subsequent gift, and his influence led the University of Edinburgh to confer upon Stiles a doctor's degree.

At the dawn of scientific activity in New England the commanding and attractive figure of Manasseh Cutler stands out. Cutler, a man of the true scientific spirit, an observer of the heavens above and of the earth beneath, is the father of New England botany. He made a noteworthy contribution to the memoirs of the American Academy, collected and described between three and four hundred plants of New England, and left seven volumes of manuscript notes, which are now in the Harvard herbarium, awaiting the editorial care of a botanical antiquary.

Among others whose names are renowned in the world of science are Silliman, leader in chemistry, mineralogy and geology, equalled only by Agassiz; Olmsted, the patient, inventive instructor, whose impulses toward original investigation were not supported by his opportunities; Loomis, interpreter of the law of storms and master of the whirlwind; Dana, the oceanographer; Newton, devoted to abstract thought, who revealed the mysteries of meteoric showers and their relation to comets, not before suggested; and Marsh, the inland explorer, whose discoveries had an important bearing on the doctrine of evolution—these all, with the brilliant corps of the Sheffield Scientific School, were men of rare ability who expounded and illustrated the laws of nature with such clearness and force that the graduates of Yale are everywhere to be counted as for certain the promoters of science.

Two agencies are conspicuous in the second era of Yale, the *American Journal of Science* and the Sheffield Scientific School. Benjamin Silliman showed great sagacity when he perceived, in 1818, the importance of publication, and established of his own motion, on a plan that is still maintained, a repository of scientific papers, which through its long history has been recognised both in Europe and in the United States as comprehensive and accurate; a just and sympathetic recorder of original work; a fair critic of domestic and foreign researches; and a constant promoter of experiment and observation. In the profit and loss account, it appears that the College has never contributed to the financial support of the journal, but it has itself gained reputation from the fact that throughout the world of science Silliman and Dana, successive editors from the first volume, have been known as members of the faculty of Yale.

Agricultural science in the United States owes much to the influences which have gone out from the Sheffield School. J. P. Norton, J. A. Porter, S. W. Johnson, and W. H. Brewer are the followers in our generation of Jared Eliot, the colonial advocate of agricultural science.

In the thirties of last century there was an informal association which may be called a voluntary syndicate for the study of astronomy; and the example and success of these Yale brethren initiated that zeal for astronomical research which distinguishes America. The Clark telescope, acquired in 1830, was then unsurpassed in the United States. One of its earliest and noteworthy revelations was the appearance of Halley's comet, which was observed, from the tower in the Athenæum, weeks before the news arrived of its having been seen in Europe. This gave an impulse to observatory projects in Cambridge and Philadelphia, and college after college soon emulated the example of Yale by establishing observatories in embryo, for the study of the heavens. The most brilliant luminary in the constellation was E. P. Mason, a genius, who died at twenty-two, having made a profound impression on his contemporaries by discoveries, observations, computations and delineations. Under the leadership of Olmsted, Herrick, Bradley, Loomis and Hamilton L. Smith were associate observers, and they were afterwards reinforced by Twining, Lyman and Newton. Chauvenet became a writer and teacher of renown, and Stoddard carried to the Nestorians the telescope that he had made at Yale under the syndicate's influence.

In the science of mineralogy Yale has long maintined the American leadership. No one is likely to overestimate the influence of the collection in the Peabody Museum upon the mind of James D. Dana, nor to overestimate the value of his treatise on mineralogy which, revised and enlarged by able cooperators, continues to be a standard text-book in every country where mineralogy is studied. In view of its recent acquisition, the Museum may almost be described as the "House of the Dinosaur." Its choice collections give an epitome of the sciences of mineralogy, crystallography, meteoroids, geology, palæontology and natural history, from the days of Silliman to those of the Danas, Brush, Marsh and Verrill.

In controversial periods the attitude of Yale has been very serviceable to the advancement of truth. The Copernican cosmography was probably accepted from the beginning although elsewhere the Ptolemaic conceptions of the universe maintained their supremacy, and the notes which Rector Pierson made on physics when he was a student in Harvard come "between the Ptolemaic theory and the Newtonian" (Dexter). When geology became a science, its discoveries were thought to be in conflict with the teachings of the Scripture. Silliman stood firm in the defence of geology, and although some of the bastions on which he relied became untenable, the keep never surrendered, the flag was never lowered. When the modern conceptions of evolution were brought forward by Darwin, Wallace and their allies, when conservatists dreaded and denounced the new interpretation of the natural world, the wise and cautious utterances of Dana at first dissipated all apprehensions of danger and then accepted in the main the conclusions of the new biological school. Marsh's expeditions to the Rocky Mountains and his marvellous discoveries of ancient life made the Peabody Museum an important repository of geological testimony to the truth of evolution.

But there are many others whose work has promoted science at Yale, and the next centennial discourse will do justice to them. Among the departed whose careers were made outside the walls of Yale, Percival, the geologist of Connecticut and Wisconsin; J. D. Whitney, the geologist of California; Chauvenet, the mathematician; Hubbard, the astronomer; Sullivant, the chief authority in mosses as Eaton is in ferns; F. A. P. Barnard, the accomplished president of Columbia; Eli Whitney, the inventor of the cotton-gin; and S. F. B. Morse, whose name is familiar from its relation to the electric telegraph—are especially entitled to honourable mention in this jubilee. So is a much older graduate, David Bushnell, the inventor of submarine explosives—the precursor of the modern torpedists.

This is a record of which Yale may well be proud; and the series of volumes which has been issued in commemoration of

the work of the University is really a stupendous monument to activity in all departments of knowledge. We are only concerned with the volumes containing papers from the scientific laboratories, but even these are of far too elaborate a character to be described adequately in this short article. Five volumes have been received, which can only be briefly noticed. Two of these, edited by Prof. F. A. Gooch, contain records of researches carried on in the Kent Chemical Laboratory of Yale University from the opening of the laboratory in 1888 to the present time. In one volume there are fifty-nine papers, and in the other forty-nine, together with a systematic index, index of authors and index of subjects. A consideration of the more familiar phenomena of optics is given by Prof. C. S. Hastings in a volume on "Light," which ought to receive the attention of students of the subject. The laboratory of invertebrate palæontology contributes a volume, edited by Prof. C. E. Beecher, on "Studies in Evolution," containing papers bearing on the investigation and study of the development of a number of invertebrate animals. The papers deal with the origin and significance of spines, structure and development of trilobites, development of the brachiopoda and miscellaneous studies in development. The fifth volume which has reached us is edited by Profs. S. L. Penfield and L. V. Pirsson, and it contains papers on the results of researches in mineralogy and petrography made in the Sheffield Scientific School of the University. The man of science needs no better evidence of the life and progress of a university than is afforded by volumes like these, which are published in New York by Messrs. Charles Scribner's Sons, and in London by Mr. Edward Arnold.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

OXFORD.—The president of Magdalen (Mr. T. H. Warren), who has always taken an active part in furthering the interests of science, has been elected a member of the Hebdomadal Council. Prof. Elliott has been elected a delegate of the University Museum.

CAMBRIDGE.—Dr. L. E. Shore, St. John's, has been reappointed University lecturer in advanced physiology, and Mr. F. F. Blackman, St. John's, University lecturer in botany. Mr. H. O. Jones, Clare, has been appointed demonstrator in organic chemistry to the Jacksonian professor, in place of the late Mr. Spivey. Mr. C. Shearer, advanced student, Trinity, has been appointed to occupy the University table in the Naples zoological station.

MR. W. MAITLAND (Aberdeen) has been appointed junior demonstrator of chemistry at University College, Sheffield, in succession to Dr. T. S. Price.

THE Report of the work of the Examinations Department of the City and Guilds of London Institute again directs attention to the fact that the general education of a large number of students who enter the technological classes is still defective, and they are consequently unable to profit, as they should do, by the special instruction they receive. Insufficient knowledge of the elementary principles of science, and particularly of such subjects as mensuration, geometry and drawing, is a frequent cause of failure of students to pass the examinations in technology. The preliminary course of instruction, and corresponding examinations, arranged by the Institute, provides a partial remedy for this defect; and the recent announcement that the Board of Education is prepared to consider suggestions from schools for grouped courses of instruction in branches of science cognate to certain trade subjects should do something to decrease the number of candidates without a knowledge of scientific principles. The Institute's Examination Committee strongly recommend students to attend courses in geometry, mathematics and elementary science, prior to, or concurrently with, the study of technology and workshop practice. "Technical instruction," it is wisely remarked, "fails altogether of its purpose if the student does not understand the 'why' and the 'wherefore' of the operations he performs. The aim of such teaching as is given in technological classes is not to make expert workmen, but to show how difficulties may be overcome, and how skill in drawing and a knowledge of the principles of science may, with sufficient practice, help to produce expert workmen. It is not the object of the Institute's examinations to test mere skill in workmanship. The craftsman's own work is the best certificate he can produce. But as evidence of training in the principles underlying the practice of his trade, the class certificate in technology has a distinct and recognised value."

THE current number of the *Record*, the organ of the National Association for the Promotion of Technical and Secondary Education, contains several interesting articles. Specimen lessons are given to show how interest in nature-knowledge may be encouraged, and how it may be assisted by Museums. It may be doubted, however, whether any useful purpose is served by creating an animistic attitude in the minds of children studying nature. The following statement, for instance, is, to say the least, misleading: "When the horse-chestnut feels winter coming on, it says to itself—you can hear the branches whispering during any autumn evening—'Dear me, my leaves will begin falling off in a minute, and there are those new leaves and things to see about in the spring; I must begin making buds this very instant.'" The child who is taught on these lines will believe that a hawthorn tree is really able to look ahead to a severe winter, and takes pains to provide plenty of haws for the birds during the forthcoming hard times.

THE funds available for purposes of technical education are the residue received under the Local Taxation (Customs and Excise) Act, direct aid from the rates, and grants from the Public Libraries rate. A Return has been issued showing the extent to which, and the manner in which, local authorities are applying these funds in (A) England, (B) Wales, and (C) Ireland. The results are summarised below, the amount shown for Wales and Monmouth, in line B, being exclusive of the amount—estimated at 43,203*l.*—to be devoted annually to intermediate and technical education under the Welsh Intermediate Education Act, 1889:—

	Total amount expended on technical education during the year 1898–99.	Total amount expended on technical education during the year 1899–1900.	Total amount raised by loan on the security of the local rate under the Technical Instruction Acts (or otherwise) during the years 1898–99 and 1899–1900 respectively.	
			Year 1898–99.	Year 1899–1900.
	£ s. d.	£ s. d.	£ s. d.	£ s. d.
(A)	830,404 17 2	876,436 6 11	104,301 2 4	80,347 10 7
(B)	35,658 11 4	33,526 1 11	1,000 0 0	—
(C)	4,549 3 1	5,172 6 3	—	10,000 0 0
	870,612 11 7	915,134 15 1	105,301 2 4	90,347 10 7

SOCIETIES AND ACADEMIES.

LONDON.

Physical Society, November 8.—Mr. T. H. Blakesley, vice-president, in the chair.—A paper on a voltameter for small currents was read by Dr. R. A. Lehfeldt. The instrument consists of a capillary tube about 25 cms. long completely filled with mercury with the exception of a bubble of mercurous nitrate solution about 1 cm. long placed near the middle of the tube. Connection with the two mercury columns is made by means of platinum wires passing through the side of the tube. To use the instrument it is placed in a vertical position, the anode being at the top, and the quantity of electricity which passes through is measured by the change in volume of either electrode. In a test experiment the change in volume was measured by means of a micrometer, and agreed within 0·6 per cent. with the amount deduced from the known value of the current. It is necessary that the currents should be small, so as to avoid complications due to polarisation. The chairman pointed out that the presence of air in the tube would render the readings inaccurate, and asked if it was necessary to apply any temperature correction. Dr. Lehfeldt said that it was quite easy to seal the tube without admitting air, and the temperature correction was negligible.—A note on a paper by Prof. Fleming and Mr. Ashton entitled "On a Model which Imitates

the Behaviour of Dielectrics," by Dr. J. Buchanan, was read by the secretary. The action of this model depends on the viscosity of a liquid, and the diagrams derived from it show by their form that the motion of the pencil which traced them approximated closely to what may be expressed by the term "motion of a viscous fluid by diffusion." In other words, the displacement curves obtained from the model and their derived velocity curves are of the same form as the graphs of certain solutions of Fourier's well-known equation $\frac{dv}{dt} = K\frac{d^2v}{dx^2}$. Lord Kelvin has shown that the potential and the current at any point in the wire of a cable can be expressed by appropriate solutions of this equation, and in the same manner by the use of solutions of this equation the diffusion of electricity into or out of the dielectric of a condenser can be treated. It appears, therefore, that the motion of the model and the diffusion of electricity in a dielectric are subject to one and the same mathematical law. The author suggests that the inventors should obtain hysteresis diagrams by cyclical loading of the springs. Prof. J. A. Fleming said he was glad that Dr. Buchanan had drawn attention again to the model because there were points about it which might be amplified with advantage. After giving a short description of the apparatus he said that Dr. Buchanan had shown that mathematically the theory of the model was the same as that of diffusion in a cable, and he suggested that there might be something more than mathematical analogy. Prof. Fleming referred to the discussion on the original paper in which Prof. Ayrton asked in what respect the model served its purpose better than a twisted wire. A twisted wire cannot represent the properties of a dielectric, because if twisted beyond the elastic limits there is a permanent set. There is no permanent set in the present model. He would like to know if a dielectric has a true conductivity, and suggested that experiments should be made by subjecting a dielectric to constant electric pressure at constant temperature, for years if necessary, and observing whether the curve of current becomes asymptotic to the zero line or to a line parallel to it. The model could be made to represent a conduction as well as a displacement current by so arranging the bottom piston that it could descend but not return. The fact that the movements of the model were similar to the diffusion of current in a cable suggested that the process of conduction in a metal was *similar* to that of displacement in a dielectric.—Mr. J. Macfarlane Gray read a note on the numerical value of the "characteristic" of water. The author referred to a paper on thermodynamics which he wrote twenty years ago and in which he supported the theory of a granular ether under enormous pressure. This theory easily explains the properties of bodies. There is a numerical characteristic for every substance in the state of vapour. This characteristic can be deduced from an analytical expression involving certain physical data which must be experimentally determined. His original number for water was 25·30693, but later experiments by Lord Rayleigh on the weight of hydrogen have altered this number to 25·33776. The author's original value for the absolute specific heat of water was 124960 "mms. lift at Paris," but recent experiments of Callendar give 126230. According to the author's theory, water commences to freeze at 95° F. and the variation of the specific heat of water at low temperatures is due to the latent heat of ice. The formation of ice particles also explains the peculiar changes in volume of water as it cools to the freezing point. The chairman asked if this theory could explain the fact that water can remain liquid below 32° F. Mr. Macfarlane Gray said it could.

PARIS.

Academy of Sciences, November 4.—M. Bouquet de la Grye in the chair.—On *Analysis situs*, by M. H. Poincaré.—On some chemical effects produced by the radium radiation, by M. Henri Becquerel. It is pointed out that the radium radiations consist of a part capable of deviation in the magnetic field, identical with the kathode rays, and a part non-deviable, a fraction of which is absorbable and the remainder extremely penetrating. Some kind of spectrum analysis is, therefore, necessary before studying the chemical action of these rays. Fresh observations are brought forward showing the action of the rays upon glass, the transformation of yellow into red phosphorus, the reduction of mercury perchloride in the presence of oxalic acid and the effect upon seeds. In the latter case it was found that prolonged exposure to the radium radiations had the effect of destroying the power of germinating in the seed.—The electrolysis of ammonium chloride in solution in liquefied ammonia, by M. Henri Moissan. Liquid ammonia at −80° C. is readily electrolysed with a potential difference of 115 volts, and it is remarkable that no nitrogen is produced. At the positive pole chlorine is evolved, and at the negative pole hydrogen, the purity of the latter being proved by analysis. Dry iodine is not attacked or dissolved by liquid ammonia at −70°, or at temperatures below this, but at higher temperatures the iodine goes into solution.—The decomposition of calcium-ammonium and of lithium-ammonium by ammonium chloride, by M. Henri Moissan. Both calcium-ammonium and lithium-ammonium react upon ammonium chloride in solution in liquid ammonia at a temperature of −80° C. Under these conditions the group ammonium could not be isolated, ammonia and hydrogen being set free.—On a new method of detecting very small electric charges, by M. R. Blondlot. Attempts were made, without success, to determine some very small electric charges by means of the usual electroscopes and electrometers. A new instrument was, therefore, constructed, details of which are given, possessing the required sensibility.—The sugars in the blood and their glycolysis, by MM. Lepine and Boulud. It is shown that the difference between diabetic blood and normal blood consists not only in the fact that the former preserves its reducing power better than the latter, but also in the decisive fact that after keeping for an hour in glass vessels at 39°, the fermentable sugar of the blood is not modified, whilst it is destroyed in normal blood.—Remarks by M. Marey on two reports on chronophotography and of a commission on physiology and hygiene.—Report by a committee appointed to examine the papers left by the late M. Halphen. The memoirs left in a state fit for publication are too few in number to publish in volume form, but it is desirable that some periodical would insert certain fragments.—Observations of the 1901 comet made at the Observatory of Santiago, Chili, and the elements of the same comet, by M. Obrecht.—Sunspots and planets, by M. Birkeland. The results given in a former paper have been recalculated, taking into account the action of the planet Saturn, but the conclusions previously arrived at are not thereby altered.—On persistent conjugated network, by M. J. Raffy.—On the adiabatic curve, by M. George Moreau. The usual equation to the adiabatic curve, $PV^{\gamma} =$ const. is obtained under the suppositions that the ratio of the specific heats, the specific heat at constant volume and the coefficient of expansion are constant. It has been shown, however, by MM. Mallard and Le Chatelier that the specific heat at constant volume is not constant, but is a linear function of the temperature, and the coefficient of expansion is also a function of the temperature. On these assumptions a more general form of the equation to the adiabatic curve is worked out.—On the chlorobromides of thallium of the type Tl_4X_6, by M. V. Thomas. The current theories of the constitution of double salts would allow of the prediction of two sesquichlorobromides of thallium. The mode of preparation of two isomers of $Tl_4Cl_3Br_3$ is described in detail.—Some reactions of trichloracetic acid, by M. A. Clermont. The ethyl ester and amide of this acid are so readily prepared that their formation may be used as tests for the acid.—Researches on some isomerides of pinacone and its derivatives, by M. Maurice Delacre. The reactions of pinacoline agree in part with the formula suggested by Butlerow $(CH_3)_3.C.CO.CH_3$, and in other respects corresponds to Friedel's formula $\overbrace{(CH_3)_2C\text{——}C}^{O}\text{—}(CH_3)_2$. As a result of the experiments here given the author inclines to the view that pinacoline contains the two substances represented by the above formulæ in a state of equilibrium.—The constitution of piceol, by MM. Ernest Charon and Démétrius Zamanos. The glucoside piceine, extracted by M. Tanret from *Pinus picea*, was shown by him to be hydrolysed by acids into glucose and a substance piceol. It is now shown that this latter substance is paraoxyacetophenone, the properties of the natural and synthetical piceols agreeing completely.—On the calculation of the amounts of water added to and cream abstracted from milk, by M. V. Génin.—On the formation of the perfume of vanilla, by M. Henri Lecomte. The following hypothesis would best appear to explain the formation of vanillin in the fruits during their preparation. The coniferine is converted into coniferyl alcohol and glucose by means of a hydrolytic ferment, crude vanilla, in fact, always containing glucose. This alcohol is then transformed into vanillin by the action of an oxydase, the existence of

which has been proved in the plant extracts in several ways. It is a curious fact that the varieties which are the most esteemed commercially are those which contain the greatest amount of this oxydase.—On the *Iboga*, on its exciting properties, its composition, and on the new alkaloid, ibogaine, which it contains, by MM. J. Dybowski and Ed. Landrin. A plant much used by the natives in the French Congo, and called by them *iboga*, has been found to owe its sustaining and fatigue-resisting properties to the presence of a new alkaloid, ibogaine, to which the constitution $C_{52}H_{66}N_6O_2$ is assigned. In small doses this substance produces a peculiar excitement, in large doses the effects resemble those due to the absorption of alcohol in excess.—The influence of methylal upon the growth of some algæ in soft water, by M. Raoul Bouilhac. Certain algæ, nostoc and *Anaboena*, were placed in nutritive solutions and exposed to light of feeble intensity, too feeble to enable the algæ to decompose carbonic acid; it was found that under these conditions growth could take place if a small quantity of methylal were present.—Researches on the formation of the ovule and the embryonic sac in the Araliaceæ and of the modifications undergone by the tegument, by M. L. Ducamp.—The germination of the spores of *Penicillium* in water, by M. Pierre Lesage.—The effects of freezing upon milk, by MM. F. Bordas and de Raczkowski.—On the secular variations of terrestrial magnetism, by M. V. Raulin.—Experiments in maritime aëronautics, by M. H. Hervé.

NEW SOUTH WALES.

Linnean Society, September 25.—Mr. J. H. Maiden, president, in the chair.—Arachnida from the South Seas, by W. J. Rainbow. Thirty-four species are enumerated, of which four are described as new, namely, *Leptodrassus insulanus*, *Argyrodes walkeri*, *Diaea bipunctata* and *D. regale*. The most interesting of them is *L. insulanus*, as it records a new locality for the genus.—On the systematic position of *Purpura tritoniformis*, Blainv., by H. L. Kesteven. Reasons are given for removing *P. tritoniformis* from *Urosalpinx* and *Cominella* and transferring it to *Purpura*. In selecting the subgenus of the latter for its reception, the resemblance of the larval shell and anatomical characters to *P. succincta* cause the writer to place it in *Trochia*. The names *Adamsia* and *Agnewia* consequently lapse into the synonymy of *Trochia*.

DIARY OF SOCIETIES.

THURSDAY, NOVEMBER 14.

MATHEMATICAL SOCIETY, at 5.30.—Linear Groups in an Infinite Field: Dr. L. E. Dickson.—Note on the Algebraic Properties of Pfaffians: J. Brill.—On Burmann's Theorem: Prof. A. C. Dixon.—The Puiseux Diagram and Differential Equations: R. W. H. T. Hudson.—Determination of all the Groups of Order 168: Dr. G. A. Miller.—An Outline of a Theory of Divergent Integrals: G. H. Hardy.—On the Representation of a Group of Finite Order as a Permutation Group; and on the Composition of Permutation Groups: Prof. W. Burnside, F.R.S.—(1) On the Inversion of Plane Stress; (2) On the Theory of Hele-Shaw's Experiments on Fluid Motion: J. H. Michell.—On the Steady Motion of a Sphere through Viscous Liquid: T. Stuart.—Addition Theorems for Hyperelliptic Integrals: A. L. Dixon.—Limits of Logical Statements: H. MacColl.

FRIDAY, NOVEMBER 15.

EPIDEMIOLOGICAL SOCIETY, at 8.30.—The President, Dr. Patrick Manson, C.M.G., F.R.S., will deliver his Inaugural Address on the Ætiology of Beriberi.

INSTITUTION OF MECHANICAL ENGINEERS, at 8.

TUESDAY, NOVEMBER 19.

ZOOLOGICAL SOCIETY, at 8.30.—Okapia, a New Genus of Giraffidæ from Central Africa: Prof. E. Ray Lankester, F.R.S.—On the Giraffe discovered by Sir Harry Johnston, K.C.B., near Mount Elgon, Central Africa: Oldfield Thomas, F.R.S.—On the Genital Organs of the Male Lepidosiren and Protopterus: J. Graham Kerr.

INSTITUTION OF CIVIL ENGINEERS, at 8.—*Paper to be further discussed*: The Discharge of Sewage into a Tidal Estuary: W. Kaye Parry and Dr. W. E. Adeney.—*And, time permitting*: The Treatment of Trades Waste Bacterially: William Naylor.

ROYAL STATISTICAL SOCIETY, at 5.30.—Local and Imperial Burdens: Lord Avebury, F.R.S.

ROYAL PHOTOGRAPHIC SOCIETY, at 8.—Japan as illustrated by Herself: J. W. Groves.

WEDNESDAY, NOVEMBER 20.

GEOLOGICAL SOCIETY, at 8.—On the Origin of Certain Concretions in the Lower Coal Measures: H. B. Stocks.—Some Remarks on the Meteorological Conditions of the Pleistocene Epoch: Nils Ekholm.—Notes on the Genus Lichas: F. R. C. Reed.

ROYAL METEOROLOGICAL SOCIETY, at 7.30.—The Exploration of the Atmosphere at sea by means of Kites: A. Lawrence Rotch.—Meteorological Phenomena in relation to the Changes in the Vertical: Prof. John Milne, F.R.S.

ROYAL MICROSCOPICAL SOCIETY, at 8.—Stereomicrography: Prof. G. P. Girdwood, preceded at 7.30 by an Exhibition of some Antipoints seen under the Microscope: Conrad Beck.

SOCIETY OF ARTS, at 8.—Opening Address: Sir William Henry Preece, K.C.B., F.R.S.

ENTOMOLOGICAL SOCIETY, at 8.

THURSDAY, NOVEMBER 21.

ROYAL SOCIETY, at 4.30.—*Probable Papers*: On Skin-currents. Part II. Observations on Cats: Dr. Waller, F.R.S.—The New Biological Test for Blood in relation to Zoological Classification: Dr. G. H. F. Nuttall.—Observations on the Cerebral Cortex of the Ape (Preliminary Communication): A. S. F. Grünbaum and Prof. Sherrington, F.R.S.—On the Inheritance of the Mental Characteristics in Man: Prof. K. Pearson, F.R.S.

LINNEAN SOCIETY, at 8.—Report on the Botanical Publications of the United Kingdom as a Part of the International Catalogue of Scientific Literature: B. Daydon Jackson.

CHEMICAL SOCIETY, at 8.—On the Oxidation of Sulphurous Acid to Dithionic Acid by Metallic Oxides: H. C. H. Carpenter.—Optically Active β-hydroxybutyric Acids: A. McKenzie.—On the Hydrochloride of Thiocarbamide: H. P. Stevens.—The Constituents of the Essential Oil of Asarum Canadense: F. B. Power and F. H. Lees.—Note on the Reduction of Trinitrobenzene and Trinitrotoluene with Hydrogen Sulphide: J. B. Cohen and H. D. Dakin.

INSTITUTION OF ELECTRICAL ENGINEERS, at 8.

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SUPPLEMENT TO "NATURE."

A MODERN TEXT-BOOK OF CHEMISTRY.

Roscoe-Schorlemmer's ausführliches Lehrbuch der Chemie. By Jul. Wilh. Brühl, Professor in the University of Heidelberg. Vol. vii. Part v., and Vol. viii. Part vi., Organic Chemistry, in cooperation with Eduard Hjelt and Ossian Aschan of the University of Helsingfors. Pp. xxvii + 1320 and xxxix + 1045. (Brunswick: Friedrich Vieweg und Sohn, 1899-1901.)

THE well-known treatise on chemistry by Roscoe and Schorlemmer, which has for so many years been a standard work in this country, is now being published in a totally revised form in Germany, and two parts of the German edition have been received for review. The preceding (sixth) volume, containing an account of the heterocyclic five-membered rings, was published in the spring of 1898, the seventh in July 1899, and the eighth in May of the present year. The ninth and concluding volume, dealing with albuminoid compounds, ptomaines, toxines and enzymes, is promised in a few months' time, so that the work has been pushed on with remarkable rapidity. Certain sections, moreover, such as the portions dealing respectively with the vegetable alkaloids and albuminoid compounds, have been published as separate monographs, the former having already been noticed in these columns by the present writer.

Taking the two volumes before us in due order, the seventh, which consists of 1320 closely printed pages, is devoted to the six-membered heterocyclic ring compounds. These comprise the pyrone, pyridine, quinoline and isoquinoline groups and their hydro-derivatives, the alkaloids related to this class, the azines, the uracil and purine compounds, the pyrazines, piperazines, quinoxalines, azine colouring-matters, kyanidines, cyanuric acid derivatives, &c. Dr. Brühl, in his prefatory notice, calls attention to the fact that the whole of this enormous mass of material has been worked up within the short period of one year, the editorial work having been concluded towards the beginning of 1899. The section on the metallic compounds of pyridine, which occupies twenty-two pages, has been contributed by Prof. Alfred Werner, of Zürich, while Prof. Emil Fischer has revised the portion relating to the purine group. We are further told in the preface that the aim of the authors has been, not only to present a complete, but also a *readable* account of modern organic chemistry, and each chapter accordingly commences with a concise but thorough historical introduction, which will be found most interesting by all who desire to follow the steps by which our knowledge of the different groups has been built up.

Comparing the present work with its English predecessor, it will be seen that the rapid development of organic chemistry has necessitated much more than mere revision. Whole sections have been re-written, and but little of the original "Roscoe and Schorlemmer" beyond the general plan is left. That this work of compilation and coordination has been carried out most thoroughly and efficiently is sufficiently guaranteed by the names of Dr. Brühl and his coadjutors. In view of the great advance of the science of chemistry in every direction, it is practically impossible to produce a text-book, however complete, which can be expected to survive for more than a limited period. Such a work as that under consideration must be considered as presenting a complete epitome of the science down to the date of its publication; and as a standard of reference for students and workers it may be confidently asserted that it is destined to have a long and useful career. How many years will elapse before a new edition is called for—whether it will be possible to keep pace with the progress of discovery by the issue of supplementary volumes, whether it may not be necessary to revise particular volumes from time to time—these are questions of procedure to which time and the exigencies of the German publishing trade can alone give a reply. But if the reader who, without being a specialist in this department of chemistry, is interested in a general way in the development of our knowledge of the carbon compounds will make such a comparison as is here suggested, he cannot fail to be struck by the manifest indications of ceaseless activity on the part of investigators in this practically inexhaustible domain. Take, for example, the purine group, which has been attacked with such brilliant success by Emil Fischer and his pupils. It is about seventeen years ago since Fischer's first communication on this subject, and at the present time it may be said that our knowledge of the constitution of all the physiologically important members of the group is fairly complete, and what makes this chapter of research so particularly interesting is that not only have the majority of these products of animal and vegetable life been synthesised, but a large number of new purine derivatives which have never been elaborated by "vital" processes have been called into existence by virtue of that mastery over the chemical molecule which invariably follows when the constitution of the type has been established. From the same point of view the pyrone group is likewise of special interest. Colouring-matters, such as chrysin, from the buds of various species of *Populus*; apigenin, which occurs as a glucoside in parsley; fisetin, from *Rhus cotinus*, *R. rhodanthema* and *Quebracho colorado*; luteolin, from *Reseda luteola*; kampheride, from the Chinese galanga root (*Alpinia officinarum*); quercetin, which occurs as a glucoside in quercitron bark (*Quercus tinctoria*) and in many other plants; rhamnetin, from buckthorn berries, &c.; isorhamnetin, from the wall-flower; morin, from fustic; euxanthone, from Indian yellow; gentisin, from the root of *Gentiana luteola*, and other well-known and definite products of vegetable origin are now known to belong to the benzo-γ-pyrone and dibenzo-γ-pyrone types. In establishing the constitution of these compounds A. G. Perkin, of the Yorkshire College, has taken an important part. Only two years ago the authors of the present volume were obliged to state, in summing up our knowledge of the benzo-γ-pyrones, that "none of these natural colouring-matters have as yet been synthesised" (p. 49). Of the dibenzo-γ-pyrone (xanthone) group, euxanthone had been synthesised by Liebermann in 1889 and gentisin by v. Kostanecki and Tambor in 1894. Since the appearance of the present volume the synthetical production of chrysin, apigenin and other natural colouring-matters of the same group has been

announced from time to time by v. Kostanecki and his colleagues. It is not improbable that before many years have elapsed the above statement concerning the benzo-γ-pyrones will have to be modified so as to read in the exactly opposite sense.

In calling the attention of English chemists to the present edition we cannot too strongly emphasise the point that the eminently readable character of the original "Roscoe and Schorlemmer" has been greatly enhanced by the revision which it has undergone in Germany. It is not only the historical treatment which makes the book such interesting reading, but the logically coherent way in which the descriptive facts and theoretical deductions are marshalled so as to lead the reader step by step from the first discovery of a compound up to the latest constitutional formulæ for the whole group. The evidence which has led to the adoption of any particular formula is given in detail, with bibliographical references in the foot-notes. If educationists of the old school should at any time challenge (as they have before now) the value of modern science as a mental discipline, we may confidently ask them to place this book in the hands of a student who has mastered the elementary principles of chemistry and request him to read conscientiously through any one of the sections and follow the work which the investigators have carried out in arriving at the results given. If after this he is not inspired with a desire to become a worker himself, or if he fails to see the logical connection of the various discoveries which have culminated in the present state of knowledge, his case may be dismissed as hopeless, and some non-chemical career recommended.[1]

The general plan of the English original is, of course, well known in this country; but it may be useful in connection with the above eulogistic statements to invite attention to the details of treatment of one or two groups taken at random. On p. 80, for example, there commences the section dealing with six-atom rings containing one nitrogen atom. This section comprises seven groups, viz. pyridine and homologues and isomerides; hydropyridines; quinoline and homologues and hydro-derivatives; the acridine group; phenanthridine and chrysidine group; quino-quinoline and naphthinoline group; and the isoquinoline group. The first only of these need be taken by way of illustration. The occurrence of the pyridine bases from the historical point of view is first considered, and a summary of the early work of Runge, Hofmann, Thomas Anderson and other investigators of "Dippel's oil" and the coal-tar bases is given in chronological order. A short paragraph on the mode of formation of pyridine bases by the destructive distillation of animal matter explains the theory first promulgated by Weidel and Ciamician that the bases originate in this process from unsaponified fats, the glycerol complex being essential for the pyrogenic synthesis of the bases. Then follows a section on the separation of the bases from bone-oil and from coal-tar, the so-called "light oil" of the latter being at present the chief source of pyridine and its homologues.

[1] A distinguished mathematician known to the writer used to take great pleasure in reading original papers on organic chemistry, although he had no practical acquaintance with the science. He considered the methods of arriving at constitutional formulæ as masterpieces of scientific reasoning.

The discussion of the constitution of pyridine occupies nine pages, full consideration being given to this subject on account of the important position which this base holds as the type of a series which comprises so many members and to which many natural alkaloids are related. The first formula considered is that of Körner and Dewar, corresponding to Kekulé's benzene ring formula. Of the various formulæ proposed as alternatives, that of Riedel and of Lieben and Haitinger, in which there is cross linkage between the nitrogen and the opposite γ-carbon atom, is alone considered as having any serious claim. The formulæ corresponding to the "prismatic" and "diagonal" benzene formulæ are dismissed in very brief paragraphs, the latter being considered as disproved by the (unpublished) spectrometric researches of Brühl. The "centric" formula proposed by Bamberger, and corresponding with the centric formula of benzene, is regarded as beyond the possibility of experimental proof, and, like the corresponding benzene formula, is considered to be outside all analogy. On the whole, while admitting that a decisive proof of the constitution is yet wanting, the original formula of Körner is shown to be most in harmony with the known facts and is adopted throughout the work.

The constitutional formula of pyridine—the parent compound of the series—having been thus threshed out, the following section is devoted to the question of isomerism and orientation among the derivatives. The synthetical formation of pyridine compounds is next dealt with. Taking the various methods in the order given, we have the formation of pyridine homologues by heating aldehydes or ketones with aldehyde-ammonia, acetamide, ammonium phosphate, &c., as first observed by v. Baeyer and Ador in 1870; then follows the general method of Hantzsch (1881), which consists in condensing β-keto-compounds (such as acetoacetic ester) with aldehydes and ammonia, and the extension of this method to diketones by Beyer and Knoevenagel (1891 and 1898). Another general method, discovered by Claisen in 1893, consists in the condensation of methenyl derivatives of certain β-diketo-compounds with ammonia. Ladenburg's intramolecular formation of the α- and γ-homologues by the action of heat on pyridinium methyl iodide and the formation of oxypyridines by the action of ammonia on α- and γ-pyrone derivatives are next considered, and attention is directed finally to the remarkable formation of pyridine derivatives from pyrrole and its homologues by the action of halogen-derivatives of methane on the potassium or sodium derivatives of the pyrroles as observed by Ciamician and his colleagues (1885–1887). The mechanism of all these synthetical processes is, of course, explained as far as known and illustrated by formulæ. After a few pages devoted to the general properties of the bases of the series, the description of the individual members is given in exhaustive detail. Beginning with pyridine itself and ending with dipyridyl, this descriptive part extends over 157 pages.

The chemistry of any of the groups dealt with in the present work can be systematically followed out by those who make use of these volumes either for the purposes of reference or in order to make themselves acquainted with the actual state of knowledge down to the date of pub-

lication. The above example is typical of the treatment throughout, and the student or worker may confidently make use of any portion of the vast mass of information crowded into every page as accurate and authoritative. It is interesting to note also how among compounds of industrial importance references to patents figure occasionally in the literary notes. We have on former occasions pointed out that discoveries of first-rate scientific importance are often in the first place published through the Patent Offices, owing to their being also of commercial value.

The larger portion of the eighth volume deals with the vegetable alkaloids, and concerning this we have only to refer our readers to the opinion expressed in the former notice (NATURE, vol. lxiii. p. 486, March 21, 1900). Dr. Brühl states in the preface that this monograph was sent to press in January 1900, and the printing concluded in October of the same year. The volume contains in addition a monograph on vegetable glucosides which occupies 138 pages, sections on bitter compounds (non-glucosidic) and natural organic colouring-matters, and sections amounting to monographs on chlorophyll and the compounds obtained from lichens. The concluding section is devoted to the indifferent or neutral compounds not previously considered. It will be only necessary to indicate very briefly the contents of these sections. The glucosides are classified according to the nature of the complex associated with the carbohydrate residue such as hydrocarbon glucosides (picrocrocin), glucosides of benzophenols, of alcohols, of aldehydes, of acids, of oxy-anthraquinone, of oxyflavone, &c., and those glucosides of which the products of hydrolysis are at present imperfectly known. The neutral bitter principles comprise compounds such as aloin, picrotoxin, podophyllotoxin, cantharidin, &c. The natural colouring-matters are classified as derivatives of pyrone, of benzophenone, of hydrindene, of naphthalene and anthracene, &c. Not the least interesting of this group of compounds are the colouring-matters derived from insects, such as cochineal, lac-dye and kermes, which are classified as hydrindene derivatives. Our knowledge of these compounds has made considerable progress of late years, as will be seen on reading this connected account of the researches of Liebermann and his pupils on carminic acid. So also it may be noted that our knowledge of the constitution of the colouring-matters of logwood, Brazil wood and of other familiar vegetable dye-stuffs has been much advanced by the work of W. H. Perkin, jun., and his colleagues. Should these ever (as is not at all improbable) come within the domain of accomplished syntheses, we might see the last of the vegetable dyes replaced by the products of chemical factories.

The section on chlorophyll is quite remarkable for its completeness, and will appeal not only to chemists, but to physiological botanists and biologists generally. It occupies more than seventy pages and comprises a bibliographical list of no less than nine pages, giving full references to all the papers and memoirs of any importance that have been written on the chemistry of this subject, the arrangement being chronological from the memoirs of Senebier in 1782–1788 down to the latest papers of Marchlewski and Schunck in 1900. Under this section there are comprised not only chlorophyll and its derivatives, but the various yellow colouring-matters which accompany chlorophyll and other related compounds Equally remarkable as a revelation of progress is the long list of lichen products, our knowledge of which has been so largely extended of late years, chiefly through the labours of Hesse and Zopf, who have won for themselves the foremost position as pioneers in this branch of plant chemistry. Nearly 100 distinct compounds of this group have now been isolated and analysed, and considerable progress has been made towards establishing the constitutional formulæ of some of them. Vulpic acid, which occurs in many lichens and which was first isolated in 1831, was synthesised by Volhard in 1894.

The prevailing impression left after looking through the contents of this eighth volume is that its interest will extend to a much wider circle of readers than those who are likely to make use of it from the purely chemical point of view. The immense number of natural products —such as alkaloids, colouring-matters, neutral compounds, chlorophyll, glucosides, lichen products, &c.— described and discussed will make this instalment of the new "Roscoe and Schorlemmer" particularly valuable to physiologists. In the words of Dr. Brühl, who in the preface calls attention to the circumstance that the present volume contains a large amount of material which has now in part undergone systematic chemical investigation for the first time :—

"Wenn dieses Material für den Chemiker mehr als alle bisher behandelten Gruppen noch Unbekanntes enthält, so ist es für den Biologen nicht minder fragenreich und von grosser Bedeutung. In dem rapiden Entwickelungsgange der Naturwissenschaften nähert sich die Chemie in neuester Zeit immer rascher den biologischen Disciplinen, und eine zusammenfassende Bearbeitung derjenigen Gegenstände, welche gegenwärtig diese Wissenszweige beschäftigen und mit der Chemie verknüpfen, wird daher zweifellos Vielen willkommen sein. Es ist in diesem Bande, mit besonderem Hinblick auf die Interessen eines weiteren naturwissenschaftlichen Kreises, zwar stets das Chemische als Hauptaufgabe behandelt, indessen auch das Biologische so weit berücksichtigt worden, als dies in einem chemischen Lehrbuch thunlich erschien."

One serious consideration arising from the publication of the present work is that a standard treatise originally planned and published in this country should now have passed out of our hands. The reading public interested in chemical literature cannot have been sufficiently numerous to warrant the publication of a revised edition in English. On the other hand, we find German chemists of the very highest repute willing to undertake the literary labour and a German firm willing to incur the risk and bear the expense of publication. The writer knows nothing of the cost of printing and publishing in Germany, but the price of the books is not less than that of the original edition in this country (vol. viii., in paper wrappers, is priced at 22 marks), so that it cannot be urged that the German student gets his text-books cheaper than the English student. The natural conclusion would appear to be that a sufficiently large number of readers in Germany can be depended upon to warrant the risk of publication of the work in that language, and this again raises the question whether the kind of scientific

literature in demand in England and Germany respectively may not be taken as an indication of the relative position of science teaching in the two countries. For depth and breadth of treatment, we naturally turn to works like that under consideration—a treatise which the facts before us now declare to be in such little demand here that the English publishers do not feel warranted in undertaking the further responsibility of issuing a revised edition. On the other hand, it may be confidently asserted that there is no other country in the world which of late years has produced such a vast number of little elementary books on chemistry. It is no exaggeration to say that books of this class can be named by hundreds. Almost every newly appointed teacher, lecturer, and professor feels it a duty to contribute to the list of what may in the majority of cases be called little cram books. Thus, while the demand for a substantial work is on the decline, there is apparently an unlimited field for manuals of the kind referred to. The system of wholesale smattering which is so characteristic of the modern educational revival in our country appears to have acted prejudicially upon the chemical literary energy of our authors and publishers, which is thus being frittered away in small efforts directed mainly towards the requirements of examining boards. It has been said with justice that in the domain of fiction magazine writing has been the curse of high-class English literature. It may with equal truth be asserted that writing up to the requirements of examining bodies has been the curse of English chemical literature. The Americans have in recent times shown a great desire to possess good textbooks of science, and their translations of certain German works are in use in this country. It only remains now for some enterprising American to bring out a translation of the new "Roscoe and Schorlemmer" to convert the position into one of ignominy for the country which first contributed this treatise to the literature of modern science.

R. MELDOLA.

PRÆ-ARYAN RELIGION IN GREECE.

Mycenaean Tree and Pillar Cult and its Mediterranean Relations. By Arthur J. Evans. "Journal of Hellenic Studies," vol. xxi. pp. 99*ff.* Pp. xii + 106. (London: Macmillan and Co., Ltd., 1901.) Price 6*s.* net.

FEW discoveries in the archæological field during the past few years have commanded such universal attention and have so profoundly modified our conception of the *origines* of European civilisation as the excavation of the Mycenæan palace and city of Knôssos in Crete by the able and energetic keeper of the Ashmolean Museum at Oxford, Mr. Arthur J. Evans. It is not many years ago since, in spite of the discoveries of Schliemann and his successors at Troy, at Mycenæ and at Tiryns, and of the steadily accumulating evidence from all parts of the Greek world, things "Mycenæan" were still looked at askance, especially by classical archæologists of the older school, who could never accustom themselves to the idea that the classical Greece which they and their forefathers for three centuries back had known by heart was but the *second* phase of Greek life and activity, that long before the First Olympiad Greece had been the seat of a magnificent and luxurious culture of which faint echoes are preserved to us in the Homeric poems, and of which the actual remains still exist upon Greek soil. The treasuries of Minyas and of Atreus still stood above ground, but none seemed to realise their intense interest; Mycenæ still existed off the road from Corinth to Argos, but nobody had thought of looking to see whether it had really been "golden" and "widewayed" until the firm belief of Schliemann in the historical reality of the Trojan War impelled him to go and look. We know what he found, and now, after twenty years, we can appreciate the revolution which he wrought in our conceptions of the earlier ages of Greece. Mr. Evans's Cretan discoveries have rivetted our attention once more upon the antiquities of the "Mycenæan" Age, and now we can see clearly, where before we saw but darkly, that the relics of the First Greece which we can hold between our hands are not those of any problematical "Mycenæan" period, the date of which was but doubtful and was, indeed, not to be too closely investigated lest it upset our traditional ideas too much—are, in fact, the relics of the Heroic Age of Greece. The Heroes existed: and here are their cities, their palaces and their works of art. No such actual personages as Agamemnon or Achilles or Minôs need ever have existed in life, but their magnificent figures undoubtedly represent the great kings who ruled in Mycenæ and the Isles, in Lacedæmon and in Crete, in times which to the Homeric singers were already ancient. The Trojan War is no sun-myth, it is a tradition of an actual occurrence. Theseus may never have actually rescued Ariadne from the Minotaur, but the Labyrinth has been laid bare by the spade of Mr. Evans, and the Cretan kings who are personified by the legendary Minôs undoubtedly lived therein and venerated there a deity to whom the bull was sacred and to whom human sacrifices were very possibly offered in remote days long before the story of Theseus and the Minotaur took shape. And now Mr. Evans has discovered and placed before us the actual hieroglyphed tablets which contain the records, the accounts, the inventories, the registers of the daily transactions of the Minoans of the Heroic Age. We cannot yet read them, but there is no doubt that no energy will be spared to attain this end. We are on the brink of discoveries which may extend our knowledge of the beginnings of Greek, and therefore also of European civilisation, in directions which cannot as yet be guessed at. We may yet read the actual historical records of events of which Greek tradition has preserved to us but distorted and imaginative accounts.

The purpose of Mr. Evans's present monograph is to arrive at some measure of certainty with regard to the religious conceptions of the Heroic Greeks on the basis of the representations of cult-scenes which they have left behind them on gems, rings, vases, &c. It is a difficult task, but one which Mr. Evans has essayed with much success, though it may seem to the reader that his treatment of it is somewhat too voluminous, that, indeed, while reading it is occasionally difficult to see the wood for the trees. This is no doubt due to Mr. Evans's unrivalled power of illustration from Greek legend and his

minute knowledge of even the most out-of-the-way hints in the classical writers which in any way bear upon the problem which he seeks to elucidate; perhaps, therefore, it should be accounted to him as a virtue rather than as a vice. We have said that Mr. Evans has discovered the veritable Labyrinth of Minôs. Unless the reader is well read in the voluminous literature, scattered through a hundred learned periodicals, of Mycenæan archæology, it will perhaps be difficult for him to appreciate all the various items of evidence which render this clear, but it is a fact which it is difficult to dispute. On p. 110 of the work under review Mr. Evans writes:—

> "In the great prehistoric Palace at present partially excavated by me at Knôssos I have ventured on many grounds to recognise the true original of the traditional Labyrinth. It is needless here to speak of its long corridors and succession of magazines with their blind endings, its tortuous passages, and maze of lesser chambers, of the harem scenes painted on its walls, and its huge fresco-paintings and reliefs of bulls, grappled perhaps by men, as on a gem impression from the same site, the Mycenæan prototype of Theseus and the Minotaur. All this might give a local colour to the mythical scenes with which the building became associated. But there is direct evidence of even a more cogent nature. It was itself the 'House of the Double Axe,' and the Palace was at the same time a sanctuary. The chief corner-stones and door-jambs, made of huge gypsum blocks, are incised with the double axe sign, implying consecration to the Cretan Zeus. More than this, in the centre of the building are two small contiguous chambers, in the middle of each of which rises a square column, formed of a series of blocks, on every side of which in one case and on three sides of the other is engraved a double axe (Fig. 5). There can, I venture to think, be little doubt that these chambers are shrines, probably belonging to the oldest part of the building, and the pillars thus marked with the sign of the god are in fact his aniconic images."

Now the double axe is known to us as the symbol of a deity, the Karian Zeus of *Labranda;* it occurs also on Carian coins and on coins of Tenedos, where it is also a god-symbol.

> "With the evidence of this primitive cult of the weapon itself before our eyes," says Mr. Evans (p. 108), "it seems natural to interpret names of Carian sanctuaries like Labranda in the most literal sense as the place of the sacred *labrys*, which was the Lydian (or Carian) name for the Greek πέλεκυς, or double-edged axe. On Carian coins indeed of quite late date the *labrys*, set up on its long pillar-like handle, with two dependent fillets, has much the appearance of a cult-image."

Now we have traditional evidence for the fact that the præ-Hellenic or Eteokretan population of Crete was ethnically connected with the inhabitants of Asia Minor, that it was, in fact, of "kleinasiatisch" stock. Many place-names in south-western Asia Minor end their Græcised forms in -νδα or -νδος, which is generally regarded as a typically Karian and Lycian termination. The Lycian language can be to a great extent read, and we know that a typically Lycian nominal affix was *-ñna*. This is the -νδα, -νδος of the Greek transliteration. Labra-*nda* or Labrau-*nda* is then "The Place of the Double Axe." Now in Crete, originally inhabited by a people ethnically connected with the speakers of Lycian and Karian, we have at Knôssos a legendary *Labyrinthos*, identified with the worship of a Zeus in connection with whom the bull was venerated. Also, one of the Curetes of Cretan legend was named *Labrandos*. Now, as Mr. Evans points out (p. 109), Jupiter Dolichenus, a Commagenian form of the double-axe god of Asia Minor, is represented standing, armed with his axe, *upon the back of a bull*. Further, on a Mycenæan gem from Argos a double axe is seen immediately above a bull's head. It is then evident that in Greece as in Asia the god of the double axe was also the god of whom the bull was an emblem, to whom the bull was sacred. In all cases this god is identified with Zeus. At Knôssos Mr. Evans finds a temple-palace devoted to the service of a god with whom the bull is constantly brought into connection and of whom the double axe is the symbol. It is a "Place of the Double Axe." At Knôssos we have the Labyrinth of legend; Λαβυρι-νθος is then naturally concluded to be the Cretan equivalent of Labra-nda; in the præ-Hellenic "kleinasiatisch" language of Crete the name signified "Place of the Double Axe." The palace of Knôssos is then the veritable Labyrinth of Minôs.[1]

Now the double axe of the Knôssian Zeus is often found on Mycenæan gems placed above a two-horned object, which must, since the axe was an object of worship, be a horned altar. When, therefore, he finds that pillars and trees are often represented in the same position as the axe, above a two-horned altar, Mr. Evans naturally concludes that the Pillar and the Tree were, equally with the Double Axe, objects of veneration to the Mycenæans of Greece proper as well as of Crete. Traces of such worships are, as he exhaustively shows, abundant in classical Greece, and there can be little doubt that in Mycenæan days they flourished exceedingly. When, however, Mr. Evans, rightly ascribing their origin to an "aniconic" period of religious development, proceeds to argue that the religion of the highly-civilised Mycenæans, the progenitors of Greek culture, had remained exclusively aniconic, it may be permissible to join issue with him: because no large Mycenæan idols have *yet* been found, we cannot say that none will ever be found, and we know that the barbaric ancestors of the Mycenæans, the "Præ-Mycenæans" of the "Island-Graves" of the Cyclades, actually did venerate rude marble idols, which are found in their tombs. And glyptic representations of Mycenæan deities are common enough. It seems preferable to hold that while anthropomorphic images of deities were probably made and worshipped by the Mycenæans, at the same time their symbols, the Pillar, the Tree, the Axe, &c., continued to be venerated.

Mr. Evans speaks of the Mycenæan altar-horns as the "Horns of Consecration," and naturally compares this article of religious furniture, as well as the Pillar and the Tree, with the horned altar, the *Maṣṣêbhâh* or sacred stone (*baitylos*), and the *Ăshêrâh* of the Semites. There is obviously a connection here, but, as Mr. Evans points out (p. 131), this connection is by no means necessarily

1 The various portions of the argument will be found discussed in Mr. Evans's monograph, by Mayer ("Mykenische Beiträge," in the *Jahrbuch des kgl. deutschen Instituts*, vii. (1892) p. 191), and in Kretschmer's "Einleitung in die Geschichte der griechischen Sprache," ch. x. p. 289 *ff.*

of the kind which is likely to be assumed by those who are well acquainted with Semitic antiquities but are not aware of the present trend of opinion with regard to the ethnology of the peoples of the Eastern Mediterranean basin. The question is not "Did the Semites influence Mycenæan religion in the matter of Tree and Pillar worship?" but rather "From whom did the Semites derive their Tree and Pillar worship?" The matter is as yet by no means clear, but all the indications, in regard to which archæology, philology, and ethnology, as exemplified in the conclusions of Evans, Kretschmer, and Sergi, concur, point to Aryan Greeks and Phrygians and Semites having been in reality the successors in Greece, north-eastern Asia Minor, and Palestine respectively of a præ-Aryan and præ-Semitic race of the same stock as the inhabitants of the greater part of Asia Minor, who were certainly neither Indo-Europeans nor Semites. It is with these people that the Tree- and Pillar-cults of both Greeks and Semites may have originated. Whether the Mycenæans of Knôssos were pure-blooded members of this præ-Hellenic and præ-Semitic "Pelasgian" race or were already mixed with Aryan Hellenic elements must remain for the present a moot question.

This seems to be the pith of Mr. Evans's arguments. He explores many byways of his subject in his exhaustive essay, but into these we have not the space to enter here, and it is easy to lose one's way in them, for they are a labyrinth as difficult to explore as Minôs's own! One point may be noticed, however; when Mr. Evans enters into comparisons of Mycenæan with Egyptian religious conceptions, we do not know that he will find Egyptologists in general inclined to agree with him. When, for instance, he compares the Mycenæan Pillar-cult with the Egyptian veneration of the well-known symbol of the Mendesian Osiris, the Ṭaṭ or Dad, often erroneously called "The Emblem of Stability," speaking of it as a "Pillar with its quadruple capital indicative of the four supports of heaven" (p. 146), he does not note that this explanation of the emblem is in the highest degree doubtful, for in all probability it is not a pillar at all, but an extremely ancient and traditionally conventionalised representation of the holiest relic of the god, the Backbone of Osiris. And if comparisons with Mycenæan heraldic designs are to be sought, the heraldic conceptions of the early Babylonians might more aptly be quoted than those of the Egyptians. Further, of Mycenæan influence on Egyptian art little trace can be found beyond the temporary adoption by the Egyptians of the false-necked vase (*Bügelkanne*); and of the remarkable evidence of this influence, which, according to Mr. Evans (p. 148), the monuments of Tell el-Amarna exhibit, nothing can be said, simply because it is in no way apparent. The naturalistic vigour of the artists of Åkhenåten's court was as purely Egyptian in its origin as was the cult of the *Åten* itself.

From the above remarks, however, it will be evident that in his monograph Mr. Evans has once again made a most notable contribution to our knowledge of Mycenæan culture, and that he has proved his main point there will be little doubt in the minds of those archæologists who are not bound by preconceived notions as to the origins of Greek civilisation. H. H.

ANCIENT MEDICINE AND BOTANY.

Magistri Salernitani nondum editi. Catalogo ragionato della Esposizione di Storia della Medicina, aperta in Torino nel 1898. By Piero Giacosa. Pp. xxxiv + 723. 8vo, with Atlas in folio. (Torino: Bocca, 1901.)

THIS fine work owes its origin to the "General Italian Exhibition," held at Turin in 1898. The author, Sig. Giacosa, suggested the formation, on that occasion, of a section for the history of medicine, in which should be collected documents illustrating that subject from the great libraries of Italy. A similar collection had been brought together at the International Medical Congress held at Rome in 1894, but, unfortunately, had been dispersed without being properly catalogued or described. It was therefore proposed also that on this occasion a complete descriptive catalogue should be prepared.

These propositions were favourably received by the Minister of Public Instruction and other authorities, with the result that, in response to invitations sent out, a large number of precious manuscripts, archives and other documents were sent in from various public libraries, forming probably the most remarkable collection of its kind ever brought together.

Most of the public libraries of Italy contributed to the exhibition, but there were certain exceptions. The absence of any contribution from the library of the Vatican is easily understood; but we regret to observe that nothing was sent from the splendid Laurentian library at Florence, which is particularly rich in works of this class.

The most remarkable part of the collection consisted of ancient medical manuscripts, dating from the ninth century onwards, many of them richly illustrated, and important in the history of art as well as in that of science. The text of many of these had never been printed, and the marvellous illustrations had remained entirely unknown except to those who were able to study them in the libraries where they are preserved. Before these treasures were again dispersed, Sig. Giacosa, assisted by eminent scholars, transcribed, and has here published, some very important inedited manuscripts, and reproduced specimens of the text by photography. In addition, some of the more remarkable pictorial illustrations which adorn the older codices have been also reproduced in the splendid atlas which accompanies the work.

The first part of the printed book consists of previously unpublished medical writings belonging to the school of Salerno, "Magistri Salernitani nondum editi." Salerno was the seat of the earliest medical school—indeed the earliest University—in Europe, which produced a medical literature of its own before the Arabian medical writers, with their versions of the Greek medical classics, occupied all the schools of Europe and formed the basis of European medicine in the Middle Ages. The study of the school of Salerno is most important in the history of medicine, and the texts published by Sig. Giacosa, which supplement in many ways the "Collectio Salernitana," edited by Henschel, Daremberg and de Renzi, nearly fifty years ago, form an important contribution to that study.

The second part of the book contains an admirable detailed description of the ancient MSS., more than one hundred in number, which were exhibited. This catalogue, containing numerous extracts with references to other MSS. and printed texts, forms, beside its immediate value, an excellent guide to the treasures of this kind preserved in Italian libraries.

It would be out of place here to enter on the interesting questions relating to the history of medicine which are raised in this volume, but we desire to call attention to the important bearings of some of these ancient works, and especially of the illustrations reproduced in the atlas, on the history of botany.

It is well known that a considerable number of works on medical botany, written in late Roman times, have come down to us and are still preserved in MS. in several European libraries. The most celebrated and probably the earliest is the MS. of Dioscorides, of the fifth century, now at Vienna, but originally brought from Naples, which is illustrated with a large number of coloured figures of plants. Another work, bearing the name of "Herbarium of Apuleius Platonicus," exists in many codices, and is always illustrated with the same series of figures, copied from one MS. to another. The ancient Anglo-Saxon version of this work, in the British Museum, with the same figures, has been printed in Mr. Cockayne's "Anglo-Saxon Leechdoms." There are others, which need not be mentioned here.

The text of these works has little botanical interest, being the work of mere servile compilers. But the illustrations have a peculiar and indeed unique value, and this *because* they are the work of copyists, who have transmitted to us, more or less accurately, a tradition of the way in which classical artists of the Roman period figured plants. The great MS. of Dioscorides is unique, or nearly so, and whether its figures were copied from still earlier figures we cannot say. But the earliest MSS. of Apuleius (ninth century) were probably copied from earlier works, and exhibit, therefore, a still earlier period in science and art.

These rich materials for a study of ancient botanical illustration have been most imperfectly explored, and have never been reproduced for the benefit of students in general. There is a printed edition of Apuleius issued by Philip de Lignamine at Rome about 1480, with rough copies of the figures in the original MS.; but the book is almost as rare as the manuscripts. The figures of the Vienna Dioscorides were copied on copper plates in the eighteenth century; but only two impressions are known to exist. A few were reproduced in Daubeny's "Roman Husbandry" and elsewhere, but they amount to very little. It would be a worthy, though costly, enterprise for some Government or academy to reproduce one of the old MSS., with its figures in their original colours.

We are therefore glad to see that Sig. Giacosa has copied in his atlas some of these ancient figures of plants. The chief characteristics of the school, viz. the diagrammatic representation of the plant with artificial symmetry, the disproportion of parts, the formal outline, and the decorative aim of the whole, can be well traced; while a comparison of figures of different dates shows the growth of conventionalism. Some realistic botanical figures of later schools form an instructive contrast.

As an example, we can only refer to the figures of one plant, the celebrated *Atropa mandragora* or mandrake, of which so many fables have been told. A comparison of the representations of this plant at different periods shows the gradual development and embellishment of the legend.

The legend of the mandragora, a formidable plant which caused the death of whoever pulled it up, so that a dog was employed in this fatal task, as told by Josephus and others, is well known. We find here, however, from a MS. of the ninth century, a fuller account than we have met with elsewhere, which it may be of interest to translate:—

"Mandragora is a plant which the poets call *anthropomercas* [sic], since it has a root shaped like a man. It is given in wine to those who wish to undergo a surgical operation safely, as when stupefied by it they feel no pain. When you come to it you will recognise it because it shines at night like a lamp. When you see its head you must cut round it with a knife lest it should escape. For such is its virtue that on the approach of an impure man it quickly flees before him. Therefore you dig round it with a knife, which must not touch the plant, and carefully remove the earth with an ivory spade. And when you see the hand and foot of the herb, tie round it a new cord and fasten the cord to the neck of a dog which has been kept fasting, and a little way off place a piece of bread so that the dog (trying to seize the bread) may pull up the herb. But if you do not wish to kill the dog, since the herb has such a divine power that it kills in an instant whoever pulls it up, proceed as follows. Make a snare of a long rod, and tie the cord which is fastened to the herb to the top of the rod, and bend it down; so that when the rod springs up by its own force it will pull up the herb mandragora."

This merciful substitute for the dog we have not found mentioned elsewhere.

All the pictures of the mandrake accordingly show the dog and the cord, sometimes a spectator, stopping his ears, lest (according to another part of the story) he should hear the shriek uttered by the herb when pulled up, which it was death to hear. In some, presumably the older figures, the herb is merely a forked tap-root with arms, the extremities ending in fibres, and surmounted by a tuft of leaves. In later figures the tuft is replaced by a well-formed human head and the fibres by distinct fingers and toes.

There are other figures of plants which, without possessing the romantic interest of the mandrake, are well worthy of study, and furnish interesting, though difficult, problems in identification. Some old botanical glossaries are also worth attention.

We have quoted enough to show the botanical interest of Signor Giacosa's beautiful work. It is an important contribution to the history of science, and should find a place in all the greater botanical as well as medical libraries. J. F. P.

THE ANDES OF PATAGONIA.

Les Andes de Patagonie. Par L. Gallois. Pp. 28 + plates. (Paris: Librairie Armand Colin, 1901.)

THIS brochure treats almost entirely of the orography of Patagonia in its relation to the boundary-line question between the Argentine Republic and Chile, which is now *sub judice*, having been submitted to the arbitration of the English Government. The author claims that his "only object in this study is to assist in making better known one of the most curious regions of the globe";

but it is easy to see which side of the controversy he would espouse if he felt himself free to give his opinion.

His brochure is richly embellished by numerous beautiful plates of mountain chains, scenery around the lake districts and along the Andean foothills, taken from the Argentine "case," as presented to the Arbitrator, in five large folio volumes. He also reproduces several Argentine Government maps on a reduced scale.

M. Gallois sets forth the salient features of the various treaties and protocols which have, during a score of years, resulted from this question, and he justly regrets that "La formule que les diplomates adoptèrent fut donc tout simplement la formule traditionelle." "S'il y avait un pays au monde où les vieilles formules dussent être avec soin évitées, c'était la Patagonie." In this opinion he is not alone, for every student of South American politics and geography must lament the interminable blunders made by diplomatists and lawyers when they rely upon their own language to determine frontier lines instead of submitting their description to scientific experts.

M. Gallois especially criticises the ignorance of the framers of the treaties regarding rivers which eat back until they have established their determined vertical curve of equilibrium. Herein is the crux of the whole dispute between the Argentine Republic and Chile. The former claims that the boundary line should be traced along the highest crests and peaks of the main Andean chain; and the latter claims that the treaties demand the tracing of the line along the continental *divortia aquarum*. But some of the rivers which flow into the Pacific Ocean have sawed back through the Cordillera and now have their sources upon the Patagonian plateau to the east of the Andean main chain. Thus the rival claims are in direct conflict. Many cases of this tendency of rivers may be found in almost every country in South America, and Colonel Church, in his "Physical Geography of South America," has given us numerous instances of it, especially in Ecuador, Perú, and Bolivia.

The brochure has a laconic but excellent description of Patagonia in a few pages, and gives due credit for information to Chilian as well as Argentine explorers. A long line of cliffs borders the Atlantic coast, interrupted at rare intervals by great valleys which open on to the sea. The surface of the immense Patagonian plateau rises gradually towards the west up to the vicinity of the Cordillera. Here and there a depression is filled with saline waters, and, especially towards the south, the country is covered with immense sheets of basaltic lava. Deep valleys, too immense for the existing streams of water, cut the plateau in certain parts and have a labyrinth of affluent cañons.

"The aspect rapidly changes along the approaches to the Cordillera. . . . It is a broken region, often mountainous, rich in prairies; rich, above all, in sheets of water, the smallest of which equals the area of our great European lakes. A privileged country, where the climate is free from extremes, where moisture is sufficient, where forests, easily penetrated, adorn the mountain sides. It is there that Argentine colonisation has been developed, and also *there* are the disputed territories.

"More to the west, but without the transition being suddenly established, commences what we call, without prejudging anything, the main chain.

"The Cordillera drops suddenly to the sea from 42° south latitude. Up to 47°, it dominates a long submerged depression which visibly continues the interior plain of Chile. . . . Further to the south the outline is less defined."

He notes the marked resemblance of this Pacific coast to that of Alaska and Norway—scored and penetrated by fjords and channels cutting the coast-line into islands and presenting numerous glaciers. Many rivers find their way to the Pacific Ocean through deeply carved valleys in the Cordillera, but so violent and broken in their course that none of them are navigable except for a very short distance from the sea.

Such is the outline that M. Gallois gives of Patagonia, and it enables the reader to acquire a very fair general knowledge of the orography and topography of the country without studying the voluminous works which have been prepared for the umpires in the boundary-line dispute. It is to the credit of M. Gallois that, however difficult, he has found it possible to preserve an impartial attitude in his instructive and ably-written brochure.

G. E. C.

WIRELESS TELEGRAPHY.

Wireless Telegraphy. By G. W. de Tunzelmann. Pp. iv + 104. (London: Office of *Knowledge*, 1901.) Price 1*s*. 6*d*.

MR. DE TUNZELMANN, in writing a popular account of wireless telegraphy, has attempted the double task of describing its historical development and of giving an account, which shall be intelligible to the lay reader, of the fundamental principles of the subject. The descriptive parts are based mainly on the papers which have been read by Mr. Marconi, and explain in an interesting manner free from superfluous detail the system which he has worked out. It is to be regretted that the work of other experimenters is hardly adequately recognised; Prof. Slaby, for example, deserves more than the half dozen lines allotted to him. Moreover, such information as is given is easily accessible in Mr. Marconi's published papers, whereas a careful comparison of the systems devised by the various workers would be a valuable addition to the literature of the subject.

In the theoretical portions of the book the author has largely drawn his inspiration from Prof. Lodge's "Modern Views of Electricity." Without wishing in any way to disparage Mr. de Tunzelmann's explanations, we doubt whether they would be intelligible to readers who, as he says in the preface, "know little or nothing of electrical theory." A clear comprehension of the constitution of the ether and the mechanism of ether waves is not to be obtained without serving a long and severe apprenticeship in the study of physical science. Yet it is supposed that the lay mind, because it is attracted by the wonderful results of wireless telegraphy, is capable of appreciating the intricate physical theories with which the subject is bound up. It is as though a man should be expected to be able to weigh the merits of the electrolytic dissociation theory because he admires the electroplate upon his dinner-table. We doubt whether any useful end is served by such "popular" expositions, which can only lead to the spread of pseudo-scientific ideas based on ill-digested theories. It must be admitted, however, that on the whole Mr. de Tunzelmann has treated the subject broadly and clearly, and his explanations should at any rate be of considerable service to the student.

M. S.

THURSDAY, NOVEMBER 21, 1901.

ZOOLOGICAL PROBLEMS STUDIED BY A PSYCHOLOGIST, PSYCHOLOGICAL PROBLEMS STUDIED BY A ZOOLOGIST.

Animal Behaviour. By C. Lloyd Morgan, F.R.S. Pp. viii + 344. (London: Arnold, 1900.) Price 10*s.* 6*d.*

THIS interesting and highly suggestive work grew out of an attempt to revise the author's "Animal Life and Intelligence." It was found that "the amended treatment would not fall conveniently under the previous scheme of arrangement." The subject is divided into seven sections, dealt with in as many chapters, the first concerned with "Organic Behaviour," the second "Consciousness," the third "Instinctive Behaviour," the fourth "Intelligent Behaviour," the fifth "Social Behaviour," the sixth "Feelings and Emotions," the seventh "Evolution of Animal Behaviour." The illustrations are numbered 1 to 26; but some of them contain several figures. Part of the work is coarse and unsightly, although clear (*e.g.* Fig. 13); on the other hand, some of the process blocks are quite successful, especially those which reproduce Mr. Charles Whymper's three drawings (Figs. 4, 5, 15). The book is well and clearly printed, and there are very few slips or misprints.

The first chapter of the work opens with an introductory section on behaviour in general, followed by an account of the more fundamental types of behaviour, viz. of cells and cell-aggregates, of plants and of reflex action, which latter is held to involve the existence of a differentiated nervous system. The chapter concludes with a section upon the evolution of consciousness, while the five succeeding chapters similarly include discussions upon the evolution, respectively, of consciousness, instinctive, intelligent, social and emotional behaviour. The last chapter is confined to the consideration of the evolution of animal behaviour. The principles which the author lays down for his guidance in the discussion of animal behaviour are the attempts to realise, in every case,

"first, the nature of the animal under consideration; secondly, the conditions under which it is placed; thirdly, the manner in which the response is called forth by the circumstances; and fourthly, how far the behaviour adequately meets the essential conditions of the situation."

A rigid adherence to these wise principles, perhaps more than anything else, leads to a sense of confidence and security as we are guided through the intricacies of this most complex subject. Our gratitude is all the more real because of the difficulty and confusion which have been gratuitously introduced into the study of animal behaviour on account of the unfortunate conviction held by nearly every owner of a domestic pet that he, or even more frequently she, is intimately acquainted with the workings of its mind, and because of the unfortunate zeal with which hasty conclusions are spread abroad. May every lover of dog stories be induced to read the observations and conclusions on dog-behaviour (p. 141 *et sqq.*), and learn caution and restraint in interpretation. And caution is not needed less, but more, when the subjects of observation are farther removed from us in the zoological system, and combine far more wonderful instincts with a psychology more difficult to penetrate because far more remote and foreign to us. Maurice Maeterlinck's charmingly written book on the bee would have been more trustworthy if its author had received the advantage of Prof. Lloyd Morgan's friendly guidance in "Animal Behaviour" and his other kindred works. Many poetically expressed motives which are believed to bring about the wonderful instincts of the bees, and thoughts which are supposed to guide them, would thus have been advantageously omitted.

In speaking of the corporate behaviour of the cell-units of the higher animals it is well pointed out that the periods of apparent rest are in reality the periods of work during which are elaborated and stored up the unstable substances in preparation for the time of action;

"just as the brilliant display of intellectual activity in a great orator is the result of the silent work of a lifetime, so is the physical manifestation of muscular power the result of the silent preparatory work of the muscle-cells."

In explaining this apparently wasteful and roundabout process the author points out that

"only thus could the organs be enabled to act under the influence of stimuli and afford examples of corporate behaviour. They are like charged batteries ready to discharge under the influence of the slightest organic touch" (p. 23).

The adaptive behaviour of plants is illustrated by a few of the most remarkable examples, such as the fertilisation of *Vallisneria* and *Catasetum*, and we are led to the safe conclusion that the behaviour, beautiful and effective as it is, "does not afford any indication of the guidance of consciousness." Nowhere among plants do we meet with

"so much as a hint of that profiting by individual experience which is the criterion of the effective presence of conscious guidance and control" (p. 31).

With the same wise caution the terms "discrimination" and "perception" are abandoned in favour of "differential reaction" in speaking of the movements of the tentacles of the sun-dew and of some of the lower animals. Thus all possibility of confusion with conscious choice is deliberately excluded.

In the brief section on the evolution of organic behaviour the author provisionally rejects the hypothesis of the hereditary transmission of acquired characters. He follows Osborn's convenient restriction of the term *modification* to the changes wrought by use or environment, and *variation* to the inherent differences which are due to the germ-cell. The distinction between these two classes of characters is carefully drawn and clearly illustrated, although the author omits to point out with sufficient clearness that the favourable *modification* is dependent no less than the favourable *variation* upon natural selection. The power of the organism to respond adaptively to environmental stimuli is probably an even higher effort of natural selection than that put forth in the production of some favourable inherent character which comes forth ready-made in the developing individual

before any occasion for its use has arisen. The relation of body-cell to germ-cell in the struggle for existence and in evolution is clearly explained in an admirable comparison with the sterile and fertile individuals of the hive. By this means two complex and difficult subjects which have puzzled many a student of evolution are together rendered easy of comprehension.

The supposed cases of the instinctive hereditary fear of the dog by the kitten, the hawk by the young turkey, &c., are examined with much care in the chapter on consciousness. This examination and the result of the author's observations, together with those of Dr. Thorndike, Mr. W. H. Hudson and Mr. Frank Finn, lead to the conclusion that an inherited timidity ready to find instant expression at any unusual sight or sound has been erroneously interpreted as the hereditary fear of certain special enemies.

The stages of the evolution of consciousness are summed up in the statement that "in the first stage we have consciousness as accompaniment; in the second, consciousness as guide; in the third, consciousness as judge."

The term *instinct* is wisely limited to behaviour which is independent of experience. Acts which, at first voluntary, have become mechanical in the course of an individual life are regarded as *acquired habits*, the popular as well as the occasional scientific use of the term *instinctive* for this purpose being rejected. The definiteness of instinct is by no means held to imply that it is rigidly the same in all individuals of a species. Individual variation, bringing instinct under the sway of natural selection, is freely admitted, as it was by both Darwin and Wallace in their joint essay in 1858. The author's position in this respect is a return to the sound principles first laid down by the great originators of the theory of natural selection and a rejection of the attempt to improve upon these principles by a widely different, and for a time very popular, conception of instinct as due to the hereditary transmission of the results of intelligent learning, practice and habit, an interpretation which received a fatal blow in Weismann's critical attack upon the evidence in favour of the transmission of acquired characters in general. The whole question is discussed in an extremely fair and convincing manner in the section on the evolution of instinct (pp. 106–116).

The full definition of instinct which is here adopted closely follows Dr. and Mrs. Peckham's summary of the conclusions to which they were led by their deeply interesting study of the solitary wasps. Instinctive behaviour comprises

"those complex groups of coordinated acts which are, on their first occurrence, independent of experience; which tend to the well-being of the individual and the preservation of the race; which are due to the co-operation of external and internal stimuli; which are similarly performed by all members of the same more or less restricted group of animals; but which are subject to variation, and to subsequent modification under the guidance of experience" (p. 71).

This is a definition which it is believed that Darwinian naturalists in general will be prepared to accept, as well as its application, *e.g.*, to the flight of birds where it is inferred

"that instinct provides a general ground plan of behaviour which intelligent acquisition, by enforcing here and checking there, perfects and guides to finer issues" (p. 88).

The whole section upon the instinctive behaviour of young birds (pp. 84–98) abounds in original observations carefully carried out and interpreted with caution and judgment; they lead the author to the conclusion that experience is not hereditary.

The chapter on intelligent behaviour opens with the discussion of simple examples which lead to the statements that

"whereas instinctive behaviour is prior to individual experience, intelligent behaviour is the outcome and product of such experience,"

and again,

"instinct depends on how the nervous system is built through heredity; while intelligence depends upon how the nervous system is developed through use."

It may be doubted whether these sound and excellently expressed principles are applied with sufficient rigidity to the wonderful behaviour of insects. Thus Dr. and Mrs. Peckham's observation of the use of a stone by the solitary wasp *Ammophila urnaria* to beat down the earth with which she was filling up the entrance of her excavation is spoken of as "intelligent procedure," and is referred to even more strongly in the words, "here we have intelligent behaviour rising to a level to which some would apply the term rational." And yet it is in every way probable, in fact almost certain, that the whole behaviour of the *Ammophila* depended upon the manner in which "the nervous system was built through heredity," and that if the American naturalists had been fortunate enough to witness the first performance of the wasp it would have been found to be as perfect as any at any later period in its life. It may be questioned whether the use of the word "tool" is to be justified in speaking of the employment of the fragment of stone. A "tool" is not any object which may be used for a purpose, but an object fashioned for the purpose it is made to serve—a criticism which was suggested to the present writer by Prof. E. Ray Lankester in a conversation about this very observation. The use of decayed wood in the construction of combs by many wasps is probably a more complex piece of behaviour and more difficult to understand as a pure instinct than the behaviour of the *Ammophila*, and yet in this case the interpretation is certain. The present writer has seen the worker of a species of *Vespa* freshly emerged from the pupa, and the sole perfect insect upon the young comb (the queen mother having been previously killed) immediately seize upon the broken material of the comb and begin accurately and with exact precision to build up the thin and delicate sides of injured cells containing the living larvæ. We may feel confident from this fact that the worker possesses a nervous system which impels it from the first to seek the right material and do the highly complex work and enables it, without intelligence, at the outset to make use of wood of the right texture, dryness, &c. The use of stones, &c., for closing the mouth of the burrow is probably as ingrained in the nervous system of *Ammophila* as the use of wood in making cells is in the genus *Vespa*. In addition to the observation of Dr. and Mrs. Peckham, we

have that of Dr. S. W. Williston upon another species, *A. yarrowi*, and still later, in the summer of 1899, the present writer and three others observed the same thing in a large species of *Ammophila* (propably *A. sabulosa*) at St. Helens, Isle of Wight. The latter observation followed very closely the account given by Dr. Williston. After the wasp had placed the larva in the burrow and, as was subsequently ascertained, laid an egg upon it, she seized, not a pebble, as in Dr. Williston's case, but a piece of peat or fibrous root, and forced it into the hole. The object of this was undoubtedly to act as a plug and prevent the earth from falling into the cell where the larva lay. Then earth was thrown upon the plug and after this an angular fragment of brick, which needed some effort to force into the tube; then more earth and a final raking of the surface and scattering of twigs, &c., which obliterated all traces of disturbance. The piece of brick seemed to be in the nature of a burglar-proof door rather than a smoothing or pounding apparatus, in this particular instance. The soil was dry and sandy and perhaps did not need such special methods. At a previous stage the wasp acted as if with intelligence in dragging the larva into the burrow and then very rapidly out again in order to enlarge it still further. But this action is also in all probability the outcome of a nervous system built through heredity which impels the wasp to bury the larva in such a manner as to provide food and space for the wasp's growing offspring. The instinct requires a trial for its complete fulfilment. The evidence required to prove intelligent behaviour would be the observation that the wasp excavated more accurately and needed fewer trials with her prey, as, in the course of her life, "the nervous system developed through use." But any such evidence is as unlikely as that the other wasps should require experience to build their combs with exactness. We are dealing, in insects, with animals which commonly require to do various elaborate acts each but once in a lifetime, and thus always "prior to individual experience." The behaviour which leads to the production of an elaborate cocoon or the burial of a larva in its earthen cell is clearly instinctive, and the most convincing evidence is required in order to prove that certain insects which perform the same elaborate act many times in their lives are guided by anything except the compulsion of a "nervous system built through heredity."

The experiments and conclusions upon the intelligent behaviour of the higher vertebrates are most convincing. They are introduced by a clear statement of the essential nature of rational behaviour and the wide difference which separates it from intelligent behaviour. The attempt made by the author and Dr. Thorndike (pp. 153, 154) to set forth the mental condition of one of the higher animals is deeply interesting. Dr. Thorndike's "animal consciousness" sometimes felt during swimming will appeal to many as a very real experience, when

"one feels the water, the sky, the birds above, but with no thoughts about them or memories of how they looked at other times, or æsthetic judgments about their beauty; one feels no ideas about what movements he will make, but feels himself make them, feels his body throughout. Self-consciousness dies away. Social consciousness dies away. The meanings, and values, and connections of things die away. One feels sense-impressions, has impulses, feels the movements he makes; that is all."

In the discussion upon the evolution of intelligent behaviour a most interesting and ingenious experiment made by the author is recorded. The close resemblance between specially protected species was explained by Fritz Müller in 1879 by the hypothesis that life was saved during the education of young and inexperienced enemies when the number of colours and patterns was few. Thus one appearance under this hypothesis may serve as a warning for many species, and it is not necessary for enemies to test more than a certain proportion of the species in order henceforth to avoid the whole. Prof. Lloyd Morgan made the following experiment in the attempt to discover whether the behaviour of a possible enemy is such as the Müllerian hypothesis assumes.

"Strips of orange and black paper were pasted beneath glass slips, and on them meal moistened with quinine was placed. On other plain slips meal moistened with water was placed. The young birds [chicks] soon learnt to avoid the bitter meal, and then would not touch plain meal if it were offered on the banded slip. And these birds, save in two instances, refused to touch cinnabar caterpillars [with black and orange bands], which were new to their experience. They did not, like other birds, have to learn by particular trials that these caterpillars are unpleasant. Their experience had already been gained through the banded glass slips; or so it seemed. I have also found that young birds who had learnt to avoid cinnabar caterpillars left wasps untouched. Such observations must be repeated and extended. But they seem to show that one aspect of the Müllerian theory is not without some facts in support of it; and, so far as they go, they afford evidence that black and orange banding, irrespective of particular form, may constitute a guiding generic feature in the conscious situation."

This evidence is of especial interest to the student of mimicry, particularly to the present writer, who ventured to suggest (*Proc.* Zool. Soc., 1887, p. 235) a Müllerian association between the cinnabar larva and the wasp.

In the account of "Müllerian mimicry" (p. 164) the hasty reader might infer that Dr. Fritz Müller had depended on Mr. Frank Finn's observations upon birds, observations made after Müller's death and about twenty years after the publication of his hypothesis. A reference to the publication, from which a sentence is quoted, would prevent any possible misconception.

Want of space prevents any discussion of the remaining chapters, which are full of interest. Prof. Groos' theory of animal play as a preparation for the serious business of life is explained in a luminous manner (pp. 248 *et sqq.*), so that the reader will gain a perfectly clear idea of one of the most important of recent contributions to Darwinian theory. Dr. Louis Robinson published an outline of this idea the year before Prof. Groos' work appeared. Thus in the Reports of the British Association for 1894, p. 778, the abstract of Dr. Robinson's paper to Section H contains these words:—

"It is found that in young apes, puppies, and other like animals, the most ticklish regions correspond to the most vulnerable spots in a fight. In the mock fights of immaturity, skill in defending these spots is attained."

And Prof. Lloyd Morgan himself had written still earlier on the same subject (*Atalanta*, January 1889).

The discussion of animal courtship and its psychological analysis constitute one of the most interesting parts of the work. The author's conclusions will, it is believed, be fully accepted by those who follow the Darwinian theory of sexual selection. The more exuberant phraseology of previous writers on the same subject was probably never intended to convey anything very different from the conduct and climax of courtship as here described. But it has required the assistance of one trained both as psychologist and as zoologist to expound the subject so that misapprehension is well-nigh impossible. The author's twofold capacity in dealing with subjects which require to be looked at from very different points of view, as expressed in the title of this review, renders, not only the discussion of courtship, but the whole work, of great value to students in two very different yet closely related fields of knowledge.

E. B. P.

CELLULOSE.

Researches on Cellulose from 1895–1900. By Cross and Bevan. Pp. vii + 180. (London: Longmans, Green and Co.) Price 6*s.* net.

VEGETABLE substances or products of vegetable origin have always had a peculiar fascination to chemists, not only because of the light which may be thrown on general chemical science, should methods of synthesis be discovered, but often because, as was the case with alizarin and more recently with indigo, huge industrial applications may be the outcome of this branch of research. Further, researches are often conducted with the hope that we may be enabled to reveal some of the hidden secrets of nature, as, for example, how the elements which are assimilated by plants in the form of the simplest of compounds become ultimately converted into some of the most complex combinations known to chemists.

In "Researches on Cellulose," by Cross and Bevan, we are dealing with a class of substances which may be said to form the structural basis of all natural organic substances. A very large amount of research has been carried out with the object of ascertaining the molecular configuration of the celluloses, but it cannot be said, up to the present, to have thrown very much light upon the ultimate structure of these substances. If the researches on cellulose have not been very fruitful in this direction, they have, on the other hand, been of enormous industrial importance. A very much larger number of industries are concerned with "cellulose" in one form or another than those who have not studied the subject are probably aware. We have only to think of the colossal scale upon which paper is manufactured and the employment of nitrocelluloses in the manufacture of smokeless powder to realise the far-reaching applications of cellulose.

The authors state in their preface that the present volume is intended as a supplement to the work which they published six years ago. The book is more or less in the form of abstracts of researches which have been published since 1895, but it also contains results of the authors' own investigations which have not previously been recorded. The chemistry of cellulose has attracted considerable attention abroad, but in England, with a few exceptions, it has been almost neglected. Messrs. Cross and Bevan call attention to this neglect, and remark that:—

"To the matter of the present volume, excluding our own investigations, there are but *two* contributions from English laboratories. We invite the younger generation of chemists to measure the probability of finding a working career in connection with the cellulose industry."

Considering the enormous importance, the vast extent and the almost unlimited possibilities of the cellulose industry, we trust that this invitation will meet with a hearty response. It is remarkable that in text-books on chemistry, with the exception of technical works—which in this country are few and far between—the subject of cellulose takes a very back-seat. But perhaps we can hardly blame the authors of such works, whose intention, generally speaking, is to teach the theory of organic chemistry. When very little is known about the theory of the subject, it is not unnatural that very little should be said about it.

The book commences with a general introduction, in which the authors reply to some of the criticisms of their previous work. They then explain in detail the plan of the book, and consider the following classification to be the most natural.

"Cellulose is in the first instance a *structure*, and the anatomical relationships supply a certain basis of classification. Next, it is known to us and is defined by the negative characteristics of resistance to hydrolytic actions and oxidations. These are dealt with in order of their intensity. Next we have the more positive definition by ultimate products of hydrolysis, so far as they are known, which discloses more particularly the presence of a greater or less proportion of furfural-yielding groups."

Until more definite knowledge of the ultimate structure of the various celluloses is known, this method of classification seems to be about the best.

The section on cellulose esters is extremely good, the paragraphs on the cellulose benzoates, which the authors have prepared by first treating fibrous cellulose (cotton) with a 10 per cent. solution of caustic soda and then with benzoyl chloride, being exceptionally interesting. It is rather interesting to note, by the way, that the dibenzoate is devoid of all structure, and is therefore readily recognised from the fibrous monobenzoate.

Under cellulose acetates the authors correct the statement made in their previous work that "on boiling cotton with acetic anhydride and sodium acetate, no reaction occurs." At the boiling point of the anhydride an ester is obtained, although without any apparent structural alteration of the fibre. Under esters is also included inorganic esters—the nitro-esters, which are of such importance in the manufacture of cordite, ballistite, "smokeless powders," &c.

The articles on *lustra-cellulose* or artificial silk will interest many, but the authors protest against the term artificial silk, and suggest that the term "*lustra-cellulose*" should be employed. Considering the manner in which the term "artificial" is so often misused, we quite agree. Inform the public that an article is artificial and they at once brand it as "false" or as a "substitute." In the

present case, lustra-cellulose is not silk at all. Why, therefore, call it silk? Messrs. Cross and Bevan likewise correct the oft-repeated statement that lustra-cellulose is highly inflammable, and point out that "Lehner" silk, which has been denitrated, contains only 0·19 per cent. of nitrogen.

There are many other sections in the book which we should like to dwell upon, but space forbids. We would only draw attention to the articles on constitution, furfuroids and industrial developments, all of which are of great interest.

The book before us is to a certain extent disjointed, but we have already stated that it consists largely of abstracts, therefore it is hardly to be expected that the authors could construct a connected narrative. In their anxiety not to *pad*, the authors have, at times, made the text almost too bare. For this reason it is sometimes hardly as clear as one could wish. This, however, is only a minor blemish. Messrs. Cross and Bevan are experts in this branch of chemistry, and have presented us with a book which is replete with important matter. It is not a book for the tyro, but we sincerely trust that it will be widely read by chemists, and we believe that research work on cellulose will be thereby greatly stimulated.

F. MOLLWO PERKIN.

OUR BOOK SHELF.

Irish Topographical Botany. By R. L. Praeger. Pp. clxxxviii + 410. (Dublin: Hodges, 1901.)

Practical Text-book of Plant Physiology. By D. T. Macdougal, Ph.D. Pp. xiv + 352. (New York and London: Longmans, Green and Co., 1901.) Price 7*s*. 6*d*. net.

THE botanical survey of a country demands a good deal from the men who undertake it, and one source of confusion now apparent in the many and various attempts being made in many and various parts of the world is the different ideals set up by different workers as to what constitutes a botanical survey. The purpose of Mr. Praeger's well-printed but somewhat heavy book is to give records of the county distribution of plants in Ireland, and the task—probably a thankless one in proportion to the labour it must have cost—seems well done. To our thinking, however, the book is only rescued from being a very dry and bulky reference list by the attempt, in Section ii. of the introduction, to sketch in outline the botanical features of Ireland in terms of plant communities.

It must be added, however, that the list appears to be very complete and is accompanied by six excellent maps, and there can be no doubt that the work will be indispensable to the reference library of the systematic botanist.

Dr. Macdougal has written an interesting and, in many ways, an excellent text-book. We have often wondered why plant physiology should so often be treated from the point of view which emphasises the obscure relations between structure and function involved in the phenomena of life and which almost ignores the many side-issues bearing on the practice of plant-culture, and it is a pleasure to see a work in which these latter are kept in view.

Many of the experiments are neat and well chosen, and the most striking are often the simplest—*e.g.* that of Molisch for demonstrating the hydrotropism of roots (Fig. 28), or that selected for showing the swelling of seeds on imbibition (Fig. 84).

Many readers would probably have wished for fuller discussion of theoretical points. The short statement on p. 215, for instance, as to the ascent of water in plants, is meagre if not misleading. The sentence on p. 8 hardly does justice to Czapek and Pfeffer's clever work on the geotropic region of the root-tip, or to Darwin's beautiful proof that the tips of *Setaria* seedlings are alone sensitive to the heliotropic stimulus, while the wholesale acceptance of Nemec's conducting fibrillæ probably needs further justification.

As sometimes happens with American books, the English reader may be startled, if not puzzled, by some of the expressions—*e.g.* "the substances illy affected" (p. 57) and "A second experiment, exploited by Pfeffer and extended by Czapek" (p. 78) seem to need explanation.

In spite of faults, however, the book may be welcomed as a useful one.

Botany, an Elementary Text for Schools. By C. H. Bailey. Pp. xiv+355. (New York: The Macmillan Company. London: Macmillan and Co., Ltd., 1900.) Price 6*s*.

THIS volume, like all Prof. Bailey's works, bears the stamp of originality, and in many respects forms an excellent model of what a school book on botany ought to be. Naturally the examples chosen for study are such as can be easily procured in America, but teachers at home might readily learn much from the author.

The details of plant-structures are introduced in a way calculated to excite the interest and attention of the learner, and the very numerous illustrations are directed to the same end. They are excellently chosen and admirably executed. The portion of the book which is devoted to an account of the minute structure of the tissues strikes us as the weakest part of the whole, and also as perhaps the least useful, having regard to the needs of beginners in the study of plants. The concluding pages give directions for forming collections of plants and for determining the species which are likely to be commonly met with.

Not the least valuable of the lessons to be drawn from Prof. Bailey's book are to be found in the preface, in which much sound advice is given as to the kind of work most suited to the needs of school children. After all, it is the training which is the thing of real value—the development of the faculties of observation and of drawing right inferences from observed facts.

(1) *Curso Elemental de Física Moderna*; (2) *Elementos de Física Moderna*. By Dr. R. Pedro Marcolain San Juan. (1) Pp. 804, with 894 woodcuts; (2) pp. 492, with 608 woodcuts. (Zaragoza: Emilio Casañal, 1900.)

THESE are two treatises on descriptive physics, of which the second book is merely an abridged edition of the first. Each is divided into three parts. The first deals with mechanics, including hydromechanics and acoustics; the second with radiology, including heat as well as light; and the third with electricity, being subdivided under the headings of electrostatics, electrodynamics and electrotechnics. In speaking of the subject-matter as descriptive physics, in contradistinction to mathematical or experimental physics, we mean to imply that the books belong to the class of popular treatises containing a general description of the properties of matter suitable for ordinary readers, and illustrated by pictures of steam engines, barometers, siphons, Atwood's machines, pumps, batteries, water boiled by cold, electric telegraphs and all that sort of thing. It is rather amusing to find in the chapter on general dynamics in the larger volume, not only an account of the *mechanism* of the Funicular Railway up Vesuvius, but also a description of the crater and of the panorama from the summit.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

Effect of a Magnetic Field on Spectra of Helium and Mercury.

THE Department of Natural Philosophy in this University has recently acquired, through a fund provided by the liberality of the Bellahouston Trustees of Glasgow, a fine echelon grating of twenty-six plates made by Hilger, London. The instrument has excellent definition, and its great power enables it to show Zeeman effects with moderate magnetic fields. In conjunction with a new electromagnet which has been constructed for the Department by Messrs. Mavor and Coulson from the same fund, we have been able to make some preliminary observations which may be of interest to readers of NATURE. The magnet and spectroscope were shown at the recent British Association meeting, when some account of the power of the set of instruments was given. The magnet when excited by a current of only five or six amperes gave a field of about 50,000 C.G.S., and was found capable of giving still higher intensities.

We have examined the Zeeman effect for the yellow helium line D_3. The line, as is well known, is a doublet; the wave-length of the brighter component is 5875·883 Ångström units, that of the fainter 5876·206 units. The lines broaden with increasing field, till at 6500 C.G.S. the fainter is a distinct doublet. As the field is increased the components of the doublet separate farther, but we have not observed any further splitting. The brighter of the D_3 pair is not distinctly resolved till the field is 9100 C.G.S., when it appears as a triplet; it remains so in higher fields.

In a very high field, the strength of which was not observed, the green (5460) line of mercury was resolved into nine components.

We have not so far come across any previous statement of these results, though of course they may be well known to observers of magneto-optic phenomena. We are now arranging for careful measurement by photography and otherwise of displacements produced by fields of known strength, in order if possible to answer some of the outstanding questions on the subject.

ANDREW GRAY.
WALTER STEWART.

Physical Laboratory, The University, Glasgow, November 15.

Observations of Leonid Meteors.

OBSERVATIONS were made of the Leonid meteors with the intention of determining the intensity and epoch of the shower. Unfortunately, however, owing to cloudy weather on November 13 and 14, observations were restricted to the three following nights. The annexed table gives the total number of meteors observed each night:—

	Extreme limits of the period during which observations were made.	Total duration of watches.	Number observed.	
			Leonids.	Other Meteors.
	h. m. h. m.	h.	h.	m.
Nov. 14	13 0–17 50	$4\frac{3}{4}$	106	94
„ 15	11 45–17 35	5	89	89
„ 16	12 15–14 15	2	7	29
Total		$11\frac{3}{4}$	202	212

During the whole of the time of observation the conditions were practically perfect, save that on the 16th there was a haze over the lower part of the sky.

The Leonids were rather less numerous during the earlier watches on the 15th than later on, but otherwise no well-defined variation in their number was noticed during the period of observation. The curious manner in which they came in groups was, however, very marked. One rather striking example of it occurred on the 15th, when three sprang out almost simultaneously, followed by another about four seconds later, and this at a time when the hourly rate was only about twenty. Their brightness varied in most cases between the 1·5 and the 3·5 magnitude, which was considerably above the mean magnitude of the other meteors. Only two meteors brighter than the first magnitude were observed, both of which were Leonids. The latter of these, which was seen on the 16th at 13h. 58m., commenced its path at 11 Monocerotis, and passing directly over μ Leporis, disappeared three degrees beyond. It left a train of irregular width, part of which remained visible for about six seconds.

No very systematic attempt was made to determine the radiant, but as far as could be judged it was at 150° + 23°, and was sharply defined at any rate for much the larger proportion of the meteors. It is, perhaps, worth mentioning that several meteors very similar to Leonids in appearance were observed to radiate from a point a little above the sickle, and it is possible that some of these, or some from other radiants, may have been recorded as Leonids. Doubtful meteors were in all cases counted with the class to which it seemed most likely they belonged.

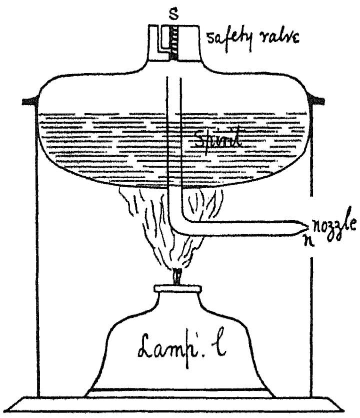
Comparing these observations with those which I made last year I should say that the shower was appreciably more intense this year on the 14th and 16th, and much more intense on the 15th. I should remark, however, that last year I recorded the maximum as occurring during the latter part of the night of the 13th, while on this occasion I have no observations for that period. For the sake of comparison, however, I may say that I consider the shower of the 14th this year about equal in intensity to that of the 13th last year. E. C. WILLIS.

Southwell Lodge, Norwich, November 18.

A Curious Flame.

FOR some time past I have shown as a lecture experiment a vibratory flame which illustrates in a striking manner phenomena similar to those to which Mr. Garbutt directs attention in your issue of October 31.

The flame (which is of the "washed-out" type) is produced by means of a common form of spirit blast-lamp, the construction of which will be sufficiently evident from the accompanying figure. If after using the blast which issues from the nozzle N,



the small subsidiary lamp L be removed from the position shown in the sketch and then placed from three to four inches in front of the nozzle, a blue flame cone will in a second or two dart back from the flame of L to N. The lamp L may now be completely removed, and the flame cone will continue—adder tongue like—to dart back and forth between N and a point three to four inches distant for hours together.

A baffle (in the form, say, of a glass tube or a knitting-needle) held in the track of the vibrating flame at a distance from N less than its normal traverse, will not permit the flame to pass it. But clearly the baffle cannot in this case *permanently* tether the flame cone. It merely curtails the amplitude of vibration without affecting materially its frequency.

If the safety-valve S be replaced by a cork carrying a U-tube the bend of which contains water, there is a rise and fall of water-level synchronising with the vibratory motion of the flame cone. The apparatus thus becomes a heat-engine producing reciprocating motion in an ideally simple manner.

If a small compound strip of ferrotype plate and zinc foil be used to baffle the flow of vapour from N, the strip curls up appreciably every time the tongue of flame licks it, uncurling again in the intervals. By including this strip in an incomplete electric bell circuit the bell may be caused to sound in synchronism with the vibrations of the flame.

Blackheath, November 11. DOUGLAS CARNEGIE.

AN ATTEMPT TO ASCERTAIN THE DATE OF THE ORIGINAL CONSTRUCTION OF STONEHENGE FROM ITS ORIENTATION.[1]

THIS investigation was undertaken in the spring of the present year, as a sequel to analogous work in Egypt and Greece, with a view to determine whether the orientation theory could throw any light upon the date of the foundation of Stonehenge, concerning which authorities vary in their estimate by some thousands of years. We beg to lay before the Royal Society the results derived from a careful study of its orientation for the purpose of arriving at the probable date of its foundation astronomically. This is not, indeed, the first attempt to obtain the date of Stonehenge by means of astronomical considerations. In Mr. Godfrey Higgins' work[2] the author refers to a method of attack connected with precession. This furnished him with the date 4000 B.C.

More recently, Dr. W. M. Flinders Petrie,[3] whose accurate plan is a valuable contribution to the study of Stonehenge, was led by his measures of the orientation to a date very greatly in the opposite direction, but, owing to an error in his application of the change of obliquity, clearly a mistaken one.

As the whole of the argument which follows rests upon the assumption of Stonehenge having been a solar temple, a short discussion of the grounds of this view may not be out of place; and, again, as the approximate date which we have arrived at is an early one, a few words may be added indicating the presence in Britain at that time of a race of men capable of designing and executing such work.

As to the first point, Diodorus Siculus (ii. 47) has preserved a statement of Hecatæus in which Stonehenge alone can by any probability be referred to.

"We think that no one will consider it foreign to our subject to say a word respecting the Hyperboreans.

"Amongst the writers who have occupied themselves with the mythology of the ancients, Hecatæus and some others tell us that opposite the land of the Celts [ἐν τοῖς αντιπέραν τῆς κελτικῆς τόποις] there exists in the Ocean an island not smaller than Sicily, and which, situated under the constellation of The Bear, is inhabited by the Hyperboreans; so called because they live beyond the point from which the North wind blows. . . . If one may believe the same mythology, Latona was born in this island, and for that reason the inhabitants honour Apollo more than any other deity. A sacred enclosure [νῆσον] is dedicated to him in the island, as well as a magnificent circular temple adorned with many rich offerings. . . . The Hyperboreans are in general very friendly to the Greeks."

The Hecatæus above referred to was probably Hecatæus of Abdera, in Thrace, fourth century B.C.; a friend of Alexander the Great. This Hecatæus is said to have written a history of the Hyperboreans: that it was Hecatæus of Miletus, an historian of the sixth century B.C., is less likely.

As to the second point, although we cannot go so far back in evidence of the power and civilisation of the Britons, there is an argument of some value to be drawn from the fine character of the coinage issued by British kings early in the second century B.C., and from the statement of Julius Cæsar (*de bello Gallico*, vi., 13) that in the schools of the Druids the subjects taught included the movements of the stars, the size of the earth and the nature of things (Multa præterea de sideribus et eorum motu, de mundi magnitudine, de rerum natura, de Deorum immortalium vi ac potestate disputant et juventuti tradunt.)

Studies of such a character seem quite consistent with, and to demand, a long antecedent period of civilisation.

The chief evidence lies in the fact that an "avenue," as it is called, formed by two ancient earthen banks, extends for a considerable distance from the structure, in the general direction of the sunrise at the summer solstice, precisely in the same way as in Egypt a long avenue of sphinxes indicates the principal outlook of a temple.

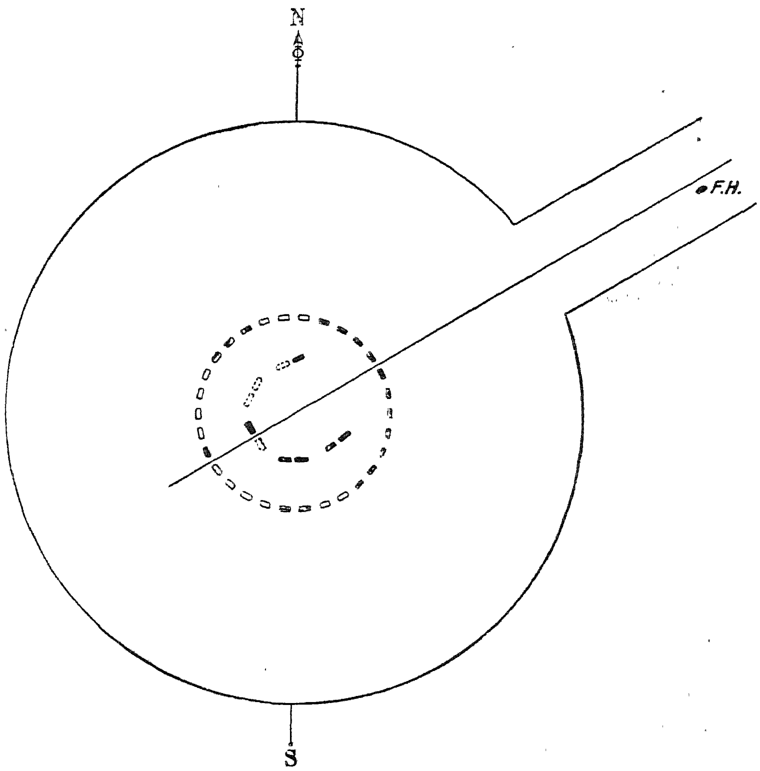


FIG. 1.—Plan of Stonehenge.

These earthen banks defining the avenue do not exist alone. As will be seen from the plan which accompanies this paper, there is a general common line of direction for the avenue and the principal axis of the structure, and the general design of the building, together with the position and shape of the Naos, indicate a close connection of the whole temple structure with the direction of the avenue. There may have been other pylon and screen equivalents as in ancient temples, which have disappeared, the object being to confine the illumination to a small part of the Naos. There can be little doubt, also, that the temple was originally roofed in, and that the sun's first ray, suddenly admitted into the darkness, formed a fundamental part of the cultus.

While the actual observation of sunrise was doubtless made within the building itself, we seem justified in taking the orientation of the axis to be the same as that

[1] By Sir Norman Lockyer, K.C.B., F.R.S., and F. C. Penrose, F.R.S., communicated to the Royal Society on October 19.
[2] "The Celtic Druids." 4to. (London, 1827.)
[3] "Stonehenge," &c. 1880.

of the avenue, and since in the present state of the south-west trilithon the direction of the avenue can probably be determined with greater accuracy than that of the temple axis itself, the estimate of date in this paper is based upon the orientation of the avenue. Further evidence will be given, however, to show that the direction of the axis of the temple, so far as it can now be determined, is sufficiently accordant with the direction of the avenue.

The orientation of this avenue may be examined upon the same principles that have been found successful in the case of Greek and Egyptian temples—that is, on the assumption that Stonehenge was a solar temple, and that the greatest function took place at sunrise on the longest day of the year. This not only had a religious motive; it had also the economic value of marking officially and distinctly that time of the year and the beginning of an annual period.

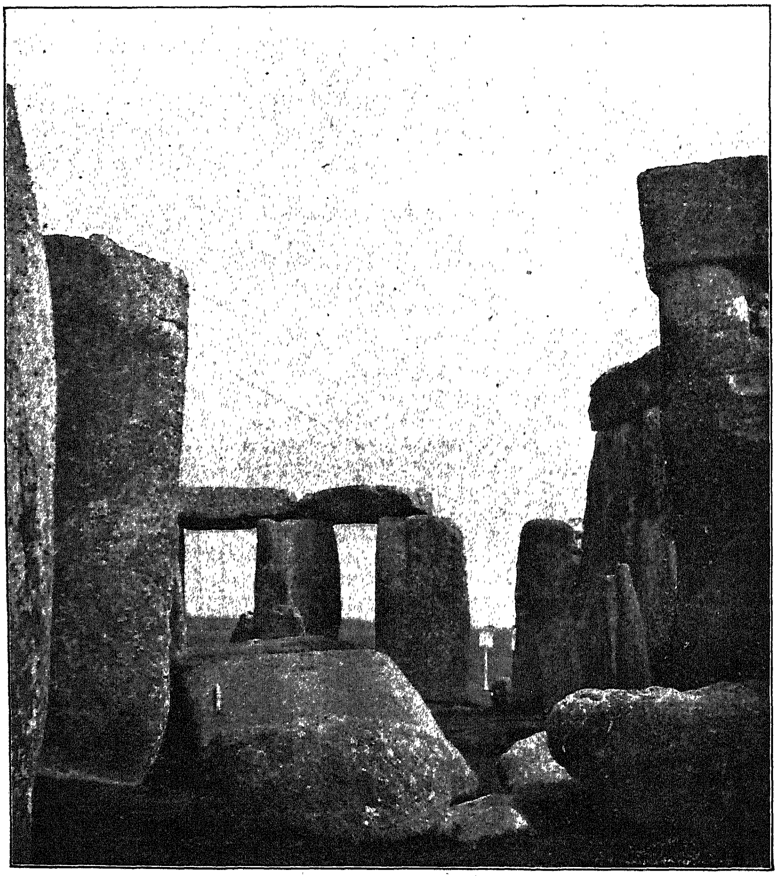


FIG. 2.—The Temple Axis (shown by the direction of the stake on the fallen stone).

It is, indeed, probable that the structure may have had other capabilities, such as being connected with the equinoxes or the winter solstice; but it is with its uses at the summer solstice alone that this paper deals.

There is this difference in treatment between the observations required for Stonehenge and those which are available for Greek or Egyptian solar temples—viz. that in the case of the latter the effect of the precession of the equinoxes upon the stars, which as warning clock stars were almost invariably connected with those temples, offers the best measure of the dates of foundation; but here, owing to the brightness of twilight at the summer solstice, such a star could not have been employed, so that we can rely only on the secular changes of the obliquity as affecting the azimuth of the point of sunrise. This requires the measurements to be taken with very great precision, towards which care has not been wanting in regard to those which we submit to the Society.

The main architecture of Stonehenge consisted of an external circle of about 100 feet in diameter composed of thirty large upright stones, named sarsens, connected by continuous lintels, and an inner structure of ten still larger stones, arranged in the shape of a horseshoe, formed by five isolated trilithons. About one-half of these uprights have fallen and a still greater number of the lintels which they originally carried. There are also other lines of smaller upright stones respecting which the only point requiring notice in this paper is that none of them would have interrupted the line of the axis of the avenue. This circular temple was also surrounded by an earthen bank, also circular, of about 300 feet in diameter, interrupted towards the north-east by receiving into itself the banks forming the avenue before mentioned, which is about 50 feet across. Within this avenue and looking north-east from the centre of the temple, at about 250 feet distance and considerably to the right hand of the axis, stands an isolated stone, which from a mediæval legend has been named the Friar's Heel.

The axis passes very nearly centrally through an intercolumnation (so to call it) between two uprights of the external circle and between the uprights of the westernmost trilithon as it originally stood. Of this trilithon the southernmost upright with the lintel stone fell in the year 1620, but the companion survived as the leaning stone which formed a conspicuous and picturesque object for many years, but happily now restored to its original more dignified and safer condition of verticality. The inclination of this stone, however, having taken place in the direction of the axis of the avenue, and as the distance between it and its original companion is known both by the analogy of the two perfect trilithons and by the measure of the mortice holes on the lintel they formerly supported, we obtain by bisection the measure (viz. 11 inches) from its edge of a point in the continuation of the central axis of the avenue and temple, and which has now to be determined very accurately. The banks which form the avenue have suffered much degradation. It appears from Sir Richard Colt Hoare's account that at the beginning of the last century they were distinguishable for a much greater distance than at present, but they are still discernible, especially on the northern side, for more than 1300 feet from the centre of the temple, and particularly the line of the bottom of the ditch from which the earth was taken to form the bank, and which runs parallel to it. Measurements taken from this line assisted materially those taken from the crown of the bank itself. With this help and by using the southern bank and ditch whenever it admitted of recognition, a fair estimate of the central line could be arrived at. To verify this, two pegs were placed at points 140 feet apart along the line near the commence-

ment of the avenue, and four others at distances averaging 100 feet apart nearer the further recognisable extremity, and their directions were measured with the theodolite, independently by two observers, the reference point being Salisbury Spire, of which the exact bearing from the centre of the temple had been kindly supplied by Colonel Johnston, R.E., the Director-General of the Ordnance Survey. The same was also measured locally by observations of the sun and of Polaris, the mean of which differed by less than 20″ from the Ordnance value. The resulting observations gave for the axis of the avenue nearest the commencement an azimuth o 49° 38′ 48″, and for that of the more distant part 49° 32′ 54″. The mean of these two lines drawn from the central interval of the great trilithon, already referred to, passes between two of the sarsens of the exterior circle, which have an opening of about 4 feet, within a few inches of their middle point, the deviation being northwards. This may be considered to prove the close coincidence of the original axis of the temple with the direction of the avenue.

This value of the azimuth, the mean of which is 49° 35′ 51″, is confirmed by the information also supplied from the Ordnance Office that the bearing of the principal bench mark on the ancient fortified hill, about eight miles distant, a well-known British encampment named Silbury or Sidbury, from the centre of the temple is 49° 34′ 18″, and that the same line continued through Stonehenge to the south-west strikes another ancient fortification, namely Grovely Castle, about six miles distant and at practically the same azimuth, viz. 49° 35′ 51″. For the above reasons 49° 34′ 18″ has been adopted for the azimuth of the avenue.

The present solstitial sunrise was also watched for on five successive mornings, viz. June 21 to 25, and was successfully observed on the latter occasion. As soon as the sun's limb was sufficiently above the horizon for its bisection to be well measured, it was found to be 8′ 40″ northwards of the peak of the Friar's Heel, which was used as the reference point, the altitude of the horizon being 35′ 48″. The azimuth of this peak from the point of observation had been previously ascertained to be 50° 39′ 5″, giving for that of the sun when measured, 50° 30′ 25″, and by calculation that of the sun with the limb 2′ above the horizon should be 50° 30′ 54″. This observation was therefore completely in accordance with the results which had been obtained otherwise.

The time which would elapse between geometrical sunrise, that is, with the upper limb tangential with the horizon, and that which is here supposed, would occupy about seventeen seconds, and the difference of azimuth would be 3′ 15″.

The remaining point is to find out what value should be given to the sun's declination when it appeared showing itself 2′ above the horizon, the azimuth being 49° 34′ 18″.

The data thus obtained for the derivation of the required epoch are these:—

(1) The elevation of the local horizon at the sunrise point seen by a man standing between the uprights of the great trilithon (a distance of about 8000 feet) is about 35′ 30″, and 2′ additional for sun's upper limb makes 37′ 30″.

(2) – Refraction + parallax, 27′ 20″.

(3) Sun's semidiameter, allowance being made for greater eccentricity than at present, 15′ 45″.

(4) Sun's azimuth, 49° 34′ 18″, and N. latitude, 51° 10′ 42″.

From the above data the sun's declination works out 23° 54′ 30″ N., and by Stockwell's tables of the obliquity, which are based upon modern determinations of the elements of the solar system,[1] the date becomes 1680 B.C.

[1] "Smithsonian Contributions to Knowledge," vol. xviii. No. 232. Table ix. (Washington, 1873.)

It is to be understood that on account of the slight uncertainty as to the original line of observation and the very slow rate of change in the obliquity of the ecliptic, the date thus derived may possibly be in error by ±200 years.

In this investigation the so-called Friar's Heel has been used only as a convenient point for reference and verification in measurement, and no theory has been formed as to its purpose. It is placed at some distance, as before-mentioned, to the south of the axis of the avenue, so that at the date arrived at for the erection of the temple the sun must have completely risen before it was vertically over the summit of the stone. It may be remarked further that more than 500 years must yet elapse before such a coincidence can take place at the beginning of sunrise.

We have to express our thanks to Sir Edmund Antrobus, Bart., for much kind assistance during our survey; and to Mr. A. Fowler and Mr. Howard Payn, for skilful and zealous cooperation in the measurements and calculations. As already stated, Colonel Duncan A. Johnston, R.E., Director-General of the Ordnance Survey, has also been good enough to furnish us with much valuable information, for which our best thanks are due.

TWO BOOKS OF TRAVEL.[1]

IN its general scope and character the first-named of these two works is very similar to Hudson's "The Naturalist in Plata"; the one giving as excellent a picture of wild animal life in the more remote parts of the United States as the other does for the Argentine Republic. Mr. Fountain, although evidently not a trained naturalist, appears to be an excellent observer of the habits of animals, and many of the facts he records, if not new, are certainly not matters of common knowledge. So far as the title is concerned, it might well be concluded that the work is a record of observations made during recent travel, but this is far from being the case, the author's journeys having been made during the 'sixties and early 'seventies, when a large part of the territory of the United States was more or less unexplored, and when the bison still swarmed in its untold thousands on the prairies. Consequently, in many respects, the observations on the fauna of the various districts traversed and on the habits and distribution of the larger mammals are far more valuable and important than any which could be made at the present day. It is perhaps to be regretted that greater pains were not taken to identify some of the animals referred to, which would have avoided certain corrections made in the appendix and have considerably increased the value of the work. Not improbably, however, the author may have had only his notes, and not actual specimens, to rely upon; and if this be so, he may well be excused the lack of the details in question. Taken altogether, with a certain allowance for more or less pardonable faults, it may truly be said to be one of the most delightful works of its kind that it has been our pleasure to read for a very long time, and it may be recommended to all lovers of Nature and a life in the wilds without a shadow of reserve.

To judge from its title (in the selection of which we think the author has scarcely done himself justice) the work might well have been taken for a record of travel, but, as a matter of fact, a very large proportion of it is

[1] "The Great Deserts and Forests of North America." By Paul Fountain. Pp. ix + 295. (London: Longmans, Green and Co., 1901.) Price 9s. 6d. net.
"Sunshine and Surf; a Year's Wanderings in the South Seas." By D. B. Hall and Lord Albert Osborne. Pp. xiv + 320. Illustrated. (London: A. and C. Black, 1901.) Price 12s. 6d.

devoted to natural history. In the first two chapters the author describes the leading features of the fauna of the Mississippi prairies at a time when, in many parts, it still existed in its pristine abundance. Like most amateur naturalists, Mr. Fountain is on the side of those who take a broad view of the limits of species, and we can fully endorse his remarks as to the close relationship of the American wolves to their Old World cousin. When, however (p. 5), he says that the American bison is a mere variety of the European species, and that the differences between the two animals are very slight, we take leave to differ from his opinions. And before putting in print a statement as to his doubts whether the number of ribs in the two is or is not identical, he might surely have taken the trouble to visit a good museum or consult some standard work on the subject.

A different phase of animal life is presented in the chapter entitled "A Day in a Cypress Swamp"; while in a later one (v.) we have many interesting observations on insects. The seventh chapter is devoted to the red man, who in some respects is viewed in a more favourable light than by many other writers. Of especial interest is the chapter headed "A Little Bit of the Desert," which is devoted to a description of Arizona and its fauna at the time when that State was an almost unknown land. This journey was made in 1871, only two years after Cope had described the poisonous lizard of Arizona, the so-called Gila monster (*Heloderma suspectum*), as a species distinct from the Mexican form. The author's account of its habits is probably one of the earliest on record, his description of how he found out its poisonous nature being an excellent instance of his careful observation.

The remaining three chapters deal with the Yosemite Valley and California and Colorado generally; and it is with a feeling of regret that limitations of space prevent our alluding to these otherwise than by name.

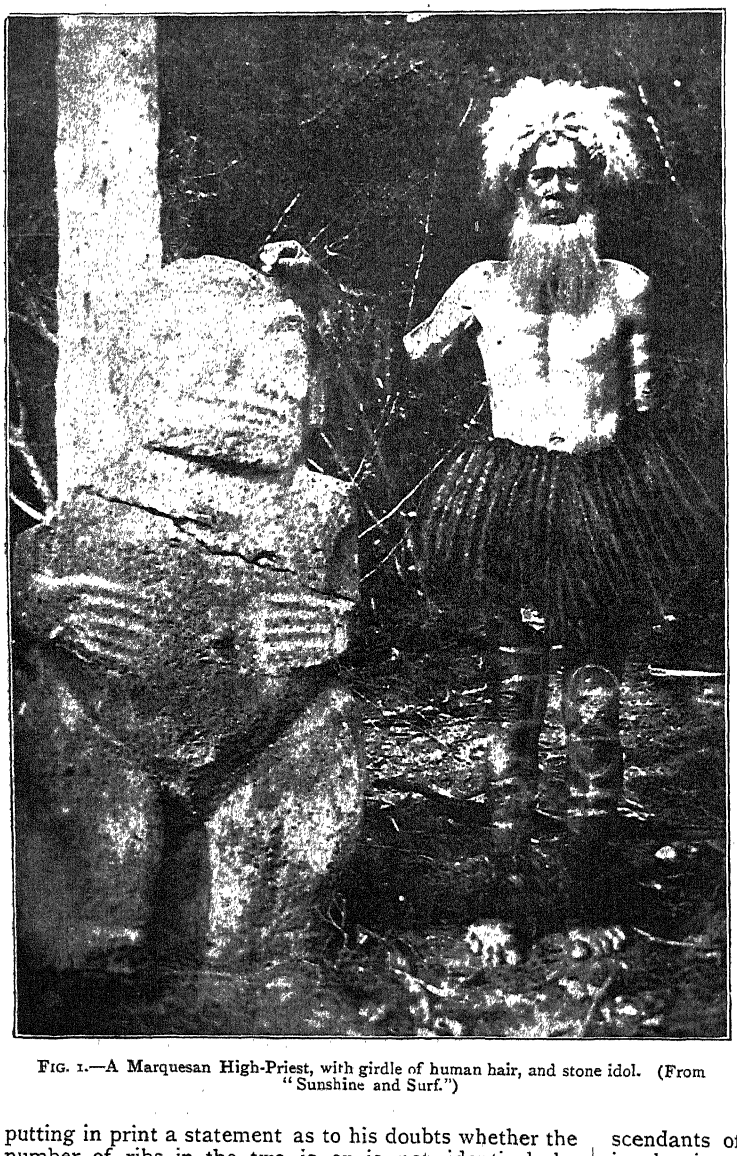


FIG. 1.—A Marquesan High-Priest, with girdle of human hair, and stone idol. (From "Sunshine and Surf.")

Very different in character from the first is the second of the two books named at the beginning of this notice, which is in the main the description of a trip to a number of the islands of the South Seas, with observations on their inhabitants and a few scattered notes on their natural history. Pleasantly written and beautifully illustrated, this work appeals more to the general reader and traveller than to the naturalist; and, in spite of the existence of such books as Kingsley's "The Earl and the Doctor" and Stevenson's "South Seas," both the former will scarcely fail to find much to interest them in its pages. The first visit of the authors was to Tahiti, with which they appear to have been as delighted—alike as regards scenery, climate and the people—as have all previous visitors. Of greater interest is the account of their visit to the Marquesas; and the excellent photograph of a Marquesan high-priest standing alongside a stone idol (herewith reproduced) should be of value to anthropologists as representing a phase of savage life rapidly on the wane. Among other interesting photographs, special mention may be made of one of a "Maori Belle" and a second of a "Samoan Beauty," the latter exhibiting the supreme development of the handsome Polynesian type. We should, however, like to know whether the Maori girl is pure-bred or a half-caste. In the islands under French rule, where it was formerly the universal custom, tattooing, the authors tell us, has been prohibited in the case of females, with a corresponding improvement in their personal appearance—at least from a European point of view. It may be added that much interesting information will be found with regard to the administration of the islands under French rule.

Much interest also attaches to the too brief remarks with regard to the feral goats, sheep and cattle—the descendants of animals introduced in 1813—now found in the interior of the Marquesas. The pleasures—and dangers—of reef-fishing are alluded to in some detail; and the authors endorse previous observations as to the diving powers of the natives, some of whom, they assert, are able to remain under water for four minutes at a time. A novel mode of shark-fishing, in which a diver fixes a running noose round the tail of the victim, is also described. But even in the South Sea Islands life has some drawbacks; and the authors speak in bitter terms of the miseries they

endured from sand-flies, centipedes and mosquitoes on certain islands, and from monstrous cockroaches on board the vessels in which they made some local trips. R. L.

NOTES.

THE close attention which the Emperor of Germany gives to scientific and technical subjects, and the personal interest he takes in the work of men who study them, have been shown on many occasions. The latest instance occurred on Monday, when, attended by a large naval staff, he was present at the annual general meeting of the Society of Naval Architects, founded three years ago on the plan of our own Institution of Naval Architects. The *Times* correspondent at Berlin states that the chief item in the programme was a lecture by Geheimrath Brinkmann on the changes which have been adopted in the disposition of guns in battleships and the results of these changes upon naval architecture. The lecturer pointed out the reasons which had caused the arrangement of the guns with the sole object of firing broadsides to be superseded. He spoke of the beginnings of independent systems of construction in Italy, in the United States and, to a certain extent, in Germany. In the course of the discussion reference was made to the advantage which Germany enjoyed in having the opportunity of constructing an entirely new navy while profiting by the experience of older naval powers, and it was pointed out that, as regards materials, German steel was excelled by none. To the surprise of the audience, the Emperor ascended the platform, and after beckoning all who were present to remain seated, spoke upon the subject of the influences of military requirements upon the development of naval construction and the disposition of artillery on ships. The presence of the Emperor at scientific and technical meetings is itself a mark of sympathy with their aims; and when, in addition, he shows himself keenly interested in the subjects discussed, the influence upon the public mind must be very great. To this influence must partly be ascribed the regard in which scientific investigation is held in Germany.

CONSIDERABLE interest attaches to a circular said to have been issued by the Italian War Office to the veterinary surgeons of the Italian Army. The circular recommends to their attention a new treatment for the so-called foot and mouth disease of cattle. The treatment was announced some little time ago by Prof. Bacelli, and consists in the intravenous injection of a solution of perchloride of mercury and sodium chloride. The intravenous injection of powerful antiseptics for specific diseases is, of course, not new. Quite recently intravenous injections of formic aldehyde were used, apparently with success, in the treatment of human pulmonary tuberculosis. We have not, up to the present, had access to the actual communication either of Prof. Bacelli or of Dr. Guzzi, who appears to have been the first to actually use the remedy in question; but it appears that the injected fluid consisted of 1 gramme of perchloride of mercury, 75 grammes of sodium chloride and 1 litre of water, and that of this solution first 30, then 50, then 70, and subsequently 100 cubic centimetres were injected. As the body-weight of the animals in question is unknown, an accurate estimation of the dose given is impossible. The ultimate remedial agent is the albuminate of mercury. The addition to the injecting fluid of the sodium chloride renders this substance more soluble, and also tends to prevent the precipitation of proteids by the perchloride, and hence the formation of emboli. The animals treated all appear to have been cured of the disease. From the general standpoint, these results, if accurate, are of interest in that they afford another instance of the possibility, by the intravenous injection of an antiseptic, of destroying, or at any rate influencing, the materies morbi without injuring the host.

A CORRESPONDENT informs us that the tercentenary of Tycho Brahe's death was celebrated in Basle, Switzerland, where Tycho settled for a time and revived interest in astronomical science. The Society of Naturalists of Basle met, with several other scientific societies, on October 23 in the Bernoullianum to listen to a lecture by Prof. Fritz Burckhardt on Tycho in Switzerland. A facsimile was shown of the letter, the original of which is preserved in the university library of Basle, with which Baron Hoffmann introduced Kepler to Tycho.

MR. A. J. EVANS, F.R.S., keeper of the Ashmolean Museum at Oxford, has been elected a corresponding member of the Munich Academy of Sciences.

WE learn from the *British Medical Journal* that on January 1, 1902, the Imperial Leopold Caroline Academy of Sciences, which has its headquarters at Halle, will celebrate the one hundred and fiftieth anniversary of its foundation. The Academy is the oldest scientific society in Germany.

THE seventh annual conference of hop growers will be held at the South-Eastern Agricultural College, Wye, on Wednesday, November 27. Colonel A. M. Brookfield, M.P., will preside, and reports will be presented on experiments conducted during 1901 on the manuring, drying, training and cultivation of hops.

THE adoption of the metric or decimal system of coinage, weights and measures in South Africa was advocated by Mr. Hutchins in a paper read before the South African Philosophical Society on October 2. It was shown that with very slight modifications the present coins and measures could be adapted to the decimal system. At the close of the meeting it was decided that a committee, consisting of Sir David Gill, Dr. Muir, Dr. Beattie, Prof. Thomson, Dr. Crawford, Mr. Littlewood and Mr. Hutchins (with power to add to their number), should prepare a report on the advisability of introducing or legalising the metric system of weights, measures and coinage in South Africa.

MR. J. STIRLING, Government Geologist and Mining Representative of Victoria, gave a lecture at the Imperial Institute on Monday on "Brown Coal-beds of Victoria, their Characters, Extent and Commercial Value." The question of utilising the large deposits of tertiary fuel known to exist in the Latrobe Valley, Gippsland, at Newport near Melbourne, Lal Lal near Ballarat, Dean's Marsh near Geelong, and at other places in Victoria, to commercial advantage in the interests of the State, is of considerable importance at the present time, when each portion of the Australian Commonwealth is taking stock of its natural resources. Geological sections run across the Latrobe Valley from north to south have disclosed the phenomenal thickness of the Morewell beds. A bore put down by the Government at Maryvale, near Morewell town, has proved 780 feet of brown-coal, in beds more than 260 feet in thickness. The chemical analyses of this fuel, taken from the bore at different levels down to 987 feet from the surface, have shown that its heat-giving qualities increase with the depth, there being from 36·75 per cent. of fixed carbon in the upper beds and 48·30 per cent. in the lower. Six hundred square miles of these tertiary brown-coal beds are known to exist in Victoria, of which 300 square miles, with 31,144,390,000 tons of the fuel, occur in the Latrobe Valley. From his intimate knowledge of these brown-coal deposits, and from the recent studies he has made on the Continent of Europe of the methods there adopted of utilising brown-coal by manufacturing it into briquettes, distilling paraffin and oils from it and producing various by-products, for all of which this class of fuel was especially adapted, Mr. Stirling has arrived at the opinion that Victoria possesses the makings of an

important national industry and that the establishment of various other industries round the centres where these brown-coal beds occur is only a question of time.

FROM a paper by Signor S. Cannizzaro in the *Atti dei Lincei* we gather that a movement is on foot in Italy for introducing the teaching of electrochemistry into the polytechnic schools of that country, and that the question has arisen as to whether this teaching should be placed in the hands of physicists or of chemists. In his paper, Signor Cannizzaro quotes the opinions of Oettel, Foerster, Lorenz, Lunge and Weber in support of the opinion that the subject falls within the domain of the chemist rather than that of the electrician.

TWO somewhat closely allied papers on Röntgen rays appear in the *Journal de Physique* for November, one by M. L. Benoist and the other by M. G. Sagnac. In the former the author finds that the general laws of transparency of different kinds of matter for Röntgen rays of different kinds can be reduced to simple forms, a result which is far from being true of other previously known forms of radiation. According to these laws the transparency depends only on the absolute and atomic weights, and it appears possible, when these data are known, to calculate the transparency of any body, however complex, for rays of given quality. On the other hand, the laws may be also taken as the basis of a classification of the rays themselves, and they suggest important applications to practical radiography and chemical analysis.

A NEW extensometer has been designed by Mr. H. T. Bovey for determining the longitudinal extension or compression of any given length of a horizontal beam loaded transversely. It consists essentially of two parallel overlapping steel bars the opposite ends of which rest by knife blades against two points on the specimen to be measured. Between the faces of the two bars is a small roller carrying a mirror. Any extension or compression of the specimen causes relative motion of the bars rotating the roller through a small angle which is readily observed by means of the mirror, the reading being effected by means of an ordinary telescope with cross hairs. In Mr. Bovey's paper, which is published in the *Transactions* of the Royal Society of Canada, experiments are described showing the variations in the position of the neutral surface in wooden beams bent by different loads.

SOME ten years ago the Berlin Meteorological Institute supplied a large number of rain gauges to the various German provinces with the view of supplementing the regular observing stations and of investigating the rainfall conditions. The fourth publication of this very useful series for the provinces of Brandenburg and Pomerania has recently appeared, having been, like the previous ones, officially prepared by Prof. G. Hellmann. The tables contain the average yearly values for 269 stations, and are very clearly represented on a map, showing by various degrees of tinting the differences of rainfall of various districts for each 50 millimetres between 450 and 750 millimetres. The mean annual value for the whole area is about 24 inches. The mean daily maximum falls amount to 1·08 inch, but the absolute daily maxima reach from 2·8 to 3·6 inches, and occasionally considerably higher. Heavy falls are much more frequent in the inland districts than on the coasts, owing to the greater frequency of thunderstorms in the former localities. The longest periods of drought are about thirty days on the coast and forty days inland, and the longest wet periods from twenty-five to thirty days. These valuable discussions may well serve as patterns for such investigations; they are beautifully printed, and issued at the low price of one mark.

IN this country we do not take much note of insect pests which damage violets, but this is not the case in the United States, where large quantites of these flowers are grown under-glass for commercial purposes. In *Bulletin* No. 27 of the Entomological Division of the U.S. Department of Agriculture, Mr. F. H. Chittenden describes a long list of insects deleterious to violets, roses and other garden plants. In the case of the violet, the worst appears to be the so-called "greenhouse leaf-tyer," which is the caterpillar of the moth *Phlyctaenia* (or, as Sir G. F. Hampson calls it, *Pioraea*) *rubigalis*, which eats away large patches from the under side of the leaves. English horticulturists are familiar with a closely allied species, *P. ferrugalis*. Various remedies are suggested for the ravages of these and other pests.

A SHORT time ago mention was made in these notes of a paper by Mr. J. J. Wilkinson on the pharynx of the "rat-tailed maggot," the larva of the fly Eristalis. To the last issue (vol. lxx. part 2) of the *Zeitschrift für Wiss. Zool.*, Dr. B. Wahl, of Graz, contributes an important memoir on the development of the hypodermal tissues of the imago in the same larva. In the same journal, Herr G. Rottmann publishes the first part of the results of his investigations into the development of the lingual ribbon, or radula, of the Mollusca, this part dealing with the cephalopods. Special interest attaches to his account of the growth and replacement of the teeth with which the radula is studded, the process being rendered clear by means of several figures in the text. A third article, by Dr. O. Maas, deals with the reproductive process in the sponges of the genus Tethya, which, as is well known, differ from all other members of the group in taking place by means of germinal buds. In another communication Dr. E. Wasmann completes his account of the parasitic flies recently discovered inhabiting the nests of white ants and named Termitoxenia.

THE *Monthly Review* for November contains an extremely interesting and well-illustrated article, by Mr. T. A. Cook, on the modern thoroughbred, dealing both with its history and its future prospects. From the evidence of contemporary documents, the author shows that the English horse previous to the introduction of the first strain of Arab blood must have been an animal endowed both with speed and endurance, and it was evidently one specially fitted to benefit by the cross in question, which has resulted, through a long and puzzling process, in the evolution of our present thoroughbred stock. Some attempts have been made to show that, because all the pedigrees of this stock can be traced back to Arab sires, the English thoroughbred is the product of Eastern blood alone, but this the author shows to be an untenable view. After noting the marked increase in the size of thoroughbreds since the date of the infusion of the Arab strain, Mr. Cook proceeds to inquire whether short-course two-year-old racing has had a deleterious effect on the endurance and stamina of the breed. On the whole, his conclusions with regard to this point are reassuring, and he notes with satisfaction a tendency at the present day to revert to long-distance racing. Should English thoroughbreds require fresh blood, the Arab strain at the present day would be useless, and it is considered that Australian and New Zealand sires would be most suitable for this purpose. Much stress is laid on the importance of preserving good portraits, and if possible models, of our best thoroughbreds; and it is suggested that when equestrian statues are made a well-known horse should be modelled. It is mentioned that in the statue of Charles I. at Charing Cross the charger is a model of a "great horse" from his Majesty's stables. The article concludes with some observations as to the best conventional mode of drawing running horses.

FROM Queensland we have received the Annual Progress Report of the Geological Survey for 1900, by Mr. W. H. Rands, Government Geologist, together with several detailed

reports by members of his staff. The chief attention of the Survey is appropriately given to questions of economic importance, but those of scientific interest are by no means neglected. Aid has been furnished by Mr. Robert Etheridge, jun., in the determination of a series of fossil corals from Stanwell, near Rockhampton, which prove to be of Permo-Carboniferous types. These are described and figured in *Bulletin* No. 12, together with a paper on the structure of the oolitic limestones by Mr. G. W. Card. The Etheridge and Gilbert goldfields in north-western Queensland are reported on by Mr. Walter E. Cameron. The reefs occur near the border of a mass of granite and lie partly in that rock and partly in adjacent schists. The same geologist has given attention to the artesian water in this northern area to the south of the Gulf of Carpentaria. The water-bearing strata occur at depths which extend to as much as 3000 feet beneath sea-level, and water has been obtained at depths of 2000 feet and upwards, with a yield varying from 100,000 to one million gallons a day. Mr. Cameron also reports on recent developments in the copper-mining industry in the Cloncurry district. The ores occur in the older metamorphic series, and further systematic explorations are strongly recommended. Mr. B. Dunstan describes the anthracitic coal-deposits of the Dawson-Mackenzie region in central Queensland; in the Annual Report of the Geological Survey of Queensland he also refers to the occurrence of rhodochrome and of barklyite (the opaque ruby). Mr. J. Malcolm Maclaren deals with the geology of the Ravenswood gold-field on the borders of the Burdekin River. The rocks comprise schists and altered sandstones of unknown age, quartz-porphyries, granitites and granites. Microscopic sections of some of the rocks are illustrated. The country rock of the reefs is mainly granitic. Mr. Maclaren reports also on the tin mines of the Stannary Hills, Eureka Creek, in North Queensland. The tinstone does not occur in fissure lodes with true walls, but as an impregnation along the bedding-planes of green chloritic slaty shales. Hence he considers that the permanency of the veins may be confidently anticipated. Mr. Lionel C. Ball reports on the Red Queen and Black Diamond gold-mines near Taromeo. The district is regarded as a promising one.

"APPENDIX No. 1—1902" of the Kew *Bulletin of Miscellaneous Information* has been issued. It consists of the usual list of seeds of hardy herbaceous annual and perennial plants and of hardy trees and shrubs, most of which have ripened in Kew during the year 1901. They are offered in exchange with Colonial, Indian, and foreign botanic gardens, as well as with regular correspondents of Kew.

THE Indian Tea Association has issued a report (published in Calcutta) on "Red Rust, a Serious Blight of the Tea-plant," by its scientific officer, Mr. Harold H. Mann. The disease is caused by an alga, *Cephaleuros mycoidea*, which attacks chiefly the leaves, one of the small number of algæ which are morbific parasites on plants. The remedy recommended is spraying with Bordeaux mixture or sulphide of potassium.

THE publication of the weekly *Botanisches Centralblatt* will cease with the close of the present year, when it will have completed its eighty-eighth quarterly volume. The chief editor, Dr. Uhlworm, has been chosen to edit a new international botanical journal, the publication of which was decided on at the recent Congress of Botanists at Geneva, subject to sufficient support being promised in the way of subscriptions.

WE learn from the *Botanical Gazette* that Dr. J. N. Rose has returned from his botanical expedition to Mexico. He has brought back a large collection of plants made chiefly in the States of Mexico, Hidalgo, Vera Cruz, and Pueblo. Considerable collections were made in the high mountains, especially about Pachucha and on Orizaba and Popocatepetl. The collection is especially rich in species of *Oxalis*, a genus which reaches a high development in Mexico.

STATISTICS issued by the Indian Department of Revenue and Agriculture show the mineral production of the Empire from 1891 to 1900. Of salt, about one million tons is annually produced; of saltpetre, about 20,000 tons. The output of coal has increased to more than six million tons. Gold has been produced to the value of about two millions sterling, mostly from Mysore. Burma and Assam have yielded 38,000,000 gallons of petroleum.

THE first number of a new periodical, entitled *Science, Arts, Nature*, has been received from Paris. The journal resembles *La Nature* in scope and typography, and the editor, M. Leon Lefevre, hopes to keep its readers in close touch with movements in science, invention and industry.

A SECOND edition of Mr. A. H. Hiorns's concise and practical manual on "Mixed Metals and Metallic Alloys" has been published by Messrs. Macmillan and Co., Ltd. The book has been completely revised and enlarged so as to include the results of the chief researches on alloys published during the last seven or eight years.

THE results of the Cambridge Anthropological Expedition to Torres Straits will be published in several volumes—probably six—dealing respectively with physical anthropology, physiology and psychology, linguistics, technology, sociology and religion. The first part, just published, belongs to the volume on physiolog and psychology, and in it Dr. W. H. R. Rivers deals with vision. We propose to notice the volumes when the series has been completed.

EVIDENCES of Austria's position among leading contributors to scientific knowledge is afforded by the annual volumes published by the Vienna Academy of Sciences. The *Sitzungsberichte* for 1899 are before us, and as they occupy approximately four thousand pages it is clearly impossible to describe the contents. Many of the papers have, however, already been mentioned in these columns, and we need now only express satisfaction at the substantial testimony to scientific activity presented to us by the volumes before us.

THE supplementary list of lantern slides just issued by Messrs. Newton and Co. contains, among other scientific subjects, sets of slides of natural history subjects reproduced from photographs by Mr. Douglas English; photographs of ripples on mercury and water surfaces by Dr. J. H. Vincent; sound waves by Prof. R. W. Wood; photo-micrographs illustrating the morphology of malaria by Dr. H. R. D. Spitta; and photo-micrographs by Dr. J. Leon Williams relating to the microscopic morphology and pathology of the enamel of teeth. To be able to illustrate lectures or lessons with these photographic pictures of natural objects and phenomena should greatly facilitate instruction and create interest in scientific subjects.

NEW editions of two volumes in the well-known Text-Books of Science series have been published by Messrs. Longmans, Green and Co. One is Sir W. de W. Abney's "Treatise on Photography," which contains the essential principles of the science of photography, and should be understood by everyone who aspires to be a successful photographer, whether from a scientific or artistic point of view. The second volume is Prof. W. A. Tilden's "Introduction to the Study of Chemical Philosophy," which has been completely revised and in large part rewritten in order to present the principles of theoretical and systematic chemistry in their modern aspects. The book is one which students of chemistry read with pleasure; because it is a synopsis of the leading principles of chemistry, and profit;

because it leads them to broad and philosophic views. Both books are tenth editions, a fact which shows that they have been appreciated; and doubtless they will maintain their high reputation for some time to come.

MESSRS. BREWSTER, SMITH AND CO. have sent us a pamphlet describing an improved form of sulphuretted hydrogen apparatus. The apparatus, which has been designed by Dr. F. M. Perkin, is so arranged that either a constant supply of the sulphuretted hydrogen gas or a saturated aqueous solution can be obtained. It is well known how rapidly an aqueous solution of sulphuretted hydrogen decomposes and becomes unfit for use. The new apparatus is so arranged that the surface of the solution has always an atmosphere of the gas over it, therefore no oxidisation can take place, and the solution is always saturated. The generating part of the apparatus is a slightly modified form of the apparatus first described by De Koninck, and contains a large supply of acid and of ferrous sulphide, so that when once fitted up it can be used for four or five months without being recharged. In this respect it is certainly an improvement over the "Kipp" apparatus, which requires constant recharging and wastes both of acid and sulphide.

THE additions to the Zoological Society's Gardens during the past week include a Squirrel Monkey (*Chrysothrix sciurea*) from Guiana, presented by Captain W. A. S. Copp; two Lesser White-nosed Monkeys (*Cercopithecus petaurista*) from West Africa, presented by Mr. P. Zaffere; two Laughing Kingfishers (*Dacelo gigantea*), a Black-backed Piping Crow (*Gymnorhina tibicen*) from Australia, presented by Captain Westcott; two Alligators (*Alligator mississippiensis*) from Southern North America, presented by Mr. Percival H. Hancock; a Common Snake (*Tropidonotus natrix*), British, presented by Mr. W. Swan Sonnenschein; a Pluto Monkey (*Cercopithecus leucampyx*) from West Africa, two Marica Gazelles (*Gazella marica*) from Arabia, a Common Roe (*Capreolus caproea albino*), European, deposited; four Lapwings (*Vanellus vulgaris*), European; fifteen American Mud Fish (*Amia calva*), twelve Long-eared Sunfish (*Lepomis auritus*), six Black Bass (*Huro nigricans*) from North America, purchased.

OUR ASTRONOMICAL COLUMN.

THE ANNULAR ECLIPSE OF THE SUN, NOVEMBER 10, 1901. —In the *Comptes rendus* (vol. cxxxiii. p. 768) there is a communication from M. Janssen stating that he has received by telegram notice of the success of the expedition sent to Cairo to observe the recent annular solar eclipse. He had requested M. de la Baume Pluvinel to photograph the spectrum of the solar light grazing the moon's limb; this had been done, and the photographs showed no trace of any absorption which might suggest the presence of a lunar atmosphere. M. Pasteur had obtained large-scale photographs of the sun with granulations. The result of the expedition was therefore to be considered entirely successful.

THE LEONID METEORS, NOVEMBER, 1901.—A telegram to the daily Press through Reuter's agency announces that a considerable number of meteors have been observed in localities where the weather conditions were propitious. Advices from many stations in the United States report more or less brilliant displays of the Leonids as having been seen on Thursday and Friday nights. A steamer from New Orleans reports having seen a great shower near Cape Hatteras early on Friday morning (November 15). The only night on which the sky was at all favourable in London was Thursday, November 14, and on that occasion continual watch was kept by three observers at the Solar Physics Observatory from 11 p.m. to 4 a.m. A few meteors were seen, from twenty to thirty, but nothing in the semblance of a definite shower was presented. Many of the shooting stars seen were very brilliant, but those traced out as being Perseids or Taurids were as numerous as those decidedly radiating from the sickle of Leo, so that probably there was nothing more than is to be seen on any good night for the same interval of time. Several photographic cameras were being exposed in different directions in the hope of recording trails, but without success. The 6-inch prismatic camera was adjusted some distance ahead of the radiant, on the star Pollux (β Geminorum), and a very bright meteor was observed to pass close to the star; but although special care was taken in development, nothing beyond the star spectrum was obtained on the plate.

STRUCTURE OF THE REGION AROUND NOVA PERSEI.— A considerable advance in the knowledge of the surroundings of Nova Persei has resulted from the examination of photographs obtained by Mr. G. W. Ritchey with the 24-inch reflector of the Yerkes Observatory. A reproduction of one of these photographs is given in the *Astrophysical Journal* (vol. xiv. pp. 167–168) in illustration of a short description of the appearances found on examining the negative. This photograph was obtained on the night of September 20, 1901, on a Cramer "Crown" plate of specially high sensitiveness, with an exposure of 3h. 50m.

The first glance at the photograph shows that the false penumbra which has been recorded with refracting telescopes is entirely absent. The image of the Nova is some 20″ in diameter on account of the long exposure, but there is little or no halo of nebulosity immediately about it. Completely surrounding the star, however, is a large elliptical belt of nebulosity some 20′ of arc in diameter, with patches of varying density, the most intense being on the southern half of the ring. These latter are probably identical with the four principal condensations mentioned by Prof. Perrine, the photographs of which with the Crossley reflector of the Lick Observatory show evidence of motion of these constituent portions of the nebula. As much of the finer detail is necessarily lost in reproduction, a drawing is appended showing the structure to be seen on the original negative. This shows the nebula to have a very complex structure, and the question as to whether it is spiral or consists of several annuli with interlacing branches cannot yet be decided. An exceedingly suggestive feature is the existence of two moderately dense wisps of nebulosity, extending from the Nova towards the west, which then curve towards the north and merge into the main convolutions of the nebula. A later circular just received from Kiel contains the important announcements that:—

November 12.—Ritchey states that a photograph obtained at the Yerkes Observatory on November 9 confirms the large motion of the nebula near the Nova.

November 13.—Ritchey finds the nebula surrounding the Nova probably expanding in all directions.

PROPER MOTION OF NOVA PERSEI.—Herr Östen Bergstrand, of Upsala, has computed a preliminary value of the proper motion of Nova Persei from measures obtained from photographs with the astrophotographic refractor at Upsala Observatory. The plates were taken on 1901 March 1, 11, and September 1, 11. The probable yearly proper motion is

$$\text{in R.A.} = \mu = -0\text{s}.\cdot 05$$
$$\text{,, Decl.} = \mu' = -0''\cdot 7.$$

The deduced mean position of the Nova is given as

$$\left.\begin{array}{l}\text{R.A.} = 3\text{h. } 24\text{m. } 28\cdot 16\text{s.}\\ \text{Decl.} = +43^\circ\ 33'\ 54''\cdot 0\end{array}\right\}\text{(Epoch 1901}\cdot 4.)$$

NEW VARIABLE STARS.—91 (1901) *Velorum*. Mr. A. W. Roberts announces the variability of the star having the position

$$\left.\begin{array}{lccc} & \text{h.} & \text{m.} & \text{s.}\\ \text{R.A.} = & 10 & 16 & 44\\ \text{Decl.} = & -41^\circ & 43'\cdot 8 & \end{array}\right\}(1875).$$

The changes observed indicate that the star is of the Algol type, with the following elements:—

Variation in brightness = 10·0–10·9 magnitude.
Period... ... ... = 1d. 20h. 30m. 2s.

92 (1901) *Coronae Australis*. The same observer also records as variable the star having the following position

$$\left.\begin{array}{lccc} & \text{h.} & \text{m.} & \text{s.}\\ \text{R.A.} = & 18 & 32 & 45\\ \text{Decl.} = & -37^\circ & 35'\cdot 8 & \end{array}\right\}(1875).$$

Variation in brightness = 8·0–9·0 magnitude.
Period... ... ... = about 185 days.

93 (1901) *Sagittae*. Herr F. Schwab, of Ilmenau, announces variability in the star B.D. + 19°·3975 :—

$$\left.\begin{array}{ll} \text{R.A.} = & 19^{\text{h}}\ 14^{\text{m}}\ 26^{\text{s}} \\ \text{Decl.} = & +19^{\circ}\ 25'\cdot 4 \end{array}\right\} (1900).$$

The variability is of the Algol type. Normally the star is about 6·5 magnitude, decreasing to nearly 9·0 magnitude, remaining here for some time and then rapidly increasing. At present there are not sufficient observations for stating a value for the period, but the light curve is similar to that of U Cephei, period 17 days. The last observed minimum was November 1 at 6·30 G.M.T. (*Astronomische Nachrichten*, Bd. 157, No. 3748).

DETERMINATION OF ORBITAL ELEMENTS.—In the *Astronomical Journal* (vol. xxii. No. 510, pp. 43–52) Mr. F. C. Moulton gives a general analysis of a method of determining the elements of orbits of all excentricities from the data supplied by three observations of position, and illustrative examples of the application of the equations derived to the cases of elliptic and parabolic orbits.

THE INTERNATIONAL MEETING OF PHYSIOLOGISTS AT TURIN.

THE fifth Triennial International Congress of Physiologists, which met at Turin in September, was the largest meeting of the kind that has assembled. The fine Institute of Physiology, under the direction of Prof. Angelo Mosso and belonging to the University, was put at the disposal of the Congress. In the neighbouring Institute of Histology was installed a museum for the exhibition of apparatus and preparations pertaining to physiology. The collection was extensive and important.

The number of communications announced for the sessions of the Congress was large enough to necessitate the institution of special accessory sittings. Sections were formed for Chemical Physiology and for Psycho-physiology. It is impossible in the space at our disposal to even mention all the material brought before the Congress, or to deal with any of the contributions fully. Preference was rightly given to communications illustrated by actual experiment or by actual preparations. A fuller verbal report has appeared in a special issue of the *Archives Italiennes de Biologie* (tome xxxvi. fasc. i.)

Among the communications coming under the head of Chemical Physiology the following may be noted.

Dr. Victor Henri (Paris) reported observations on the law of the quantitative action of sucrase. If a represent the quantity of saccharose at outset, and x the quantity inverted in a period equal to t, the action does not proceed in conformity with the logarithmic law admitted by authors, $K = \frac{1}{t} \log \frac{a}{a-x}$. The value of K does not remain constant during the reaction. The law in accordance with which the reaction proceeds corresponds with a formula, $K_1 = \frac{1}{t} \log \frac{a+x}{a-x}$. The *constant of inversion* K_1 varies with the concentration of the solution of saccharose a. The product aK_1 increases with a for weak concentrations (below 5 per cent.); it remains constant for concentrations of medium strength (5 per cent. to 25 per cent.) and diminishes when a increases above 25 per cent. The fact of having acted several hours and of being in a solution laden with invert sugar does not exert appreciable influence upon the activity of the sucrase.

Dr. Frederic S. Lee (New York) reported observations made by himself and Dr. C. C. Harrold on the influence of the ingestion of sugar upon *rigor mortis*. The prolonged administration of phloridzin to fasting cats causes the muscles to pass into *rigor* within a few minutes after death. If before death dextrose be given to such phloridzinised animals, the oncoming of *rigor* is delayed. The absence of carbohydrate from the muscle favours development of *rigor mortis*; it is, on the other hand, unfavourable to contraction.

Dr. F. S. Locke (London) demonstrated by a striking experiment the action of dextrose upon the activity of the mammalian heart. The heart removed from a freshly killed rabbit was washed free from blood and suspended freely, and arrangement made for recording its contractions by means of a lever attached to the apex. Kept at a temperature of 35° C., and fed with a modified Ringer's fluid, the contractions gradually grew feeble and ultimately very weak. If then oxygen under pressure were introduced into the fluid feeding the coronary arteries, the beats rapidly increased and remained good for an hour or so, and then once more diminished and failed. Dextrose then added to the feeding fluid to the extent of 1 per cent. restored the beat once more and it continued with hardly noticeable failure for ten hours or so. The beating fails at once if for the dextrose in the feeding fluid the oxygenated Ringer solution without any dextrose is substituted; but the beat is at once restored on returning again to the sugared fluid. Sucrose, lævulose and other sugars as yet tried fail to give evidence of this restorative power. The author must be congratulated upon the able and complete manner in which he demonstrated these important facts.

Prof. Albertoni (Bologna) communicated observations on absorption of various sugars from the stomach and intestine. The sugars (glucose, saccharose, lactose) were not absorbed in the ratio of their osmotic tensions. The absorption of lactose, whether in low tension or high tension solutions, was always less than for glucose or saccharose. In the intestine he always found a fluid of higher osmotic tension than the blood. During the absorption of sugar he found a slight increase of the osmotic tension of the blood.

Prof. Röhmann (Breslau) brought forward observations on the absorption of sugars from the intestine. Equal quantities of equally concentrated solutions of hexoses (glucose, galactose, mannose, fructose, and of pentoses (arabinose and xylose) placed in the small intestine (Vella's fistula) showed at the end of an hour loss by absorption of the different stereoisomeric sugars to very different extents. The absorption is, therefore, dependent, not only on the osmotic tension, but also on the configuration of the molecule of the sugar. The absorption of the disaccharides (saccharose, lactose and maltose) was further studied in respect to the extent to which their cleavage into monosaccharides went forward. It was found that a considerable though variable proportion of these disaccharides was absorbed without cleavage occurring in the intestinal canal. But an extract of the intestinal *mucosa* could produce the cleavage; probably the portion absorbed without being split up later underwent cleavage in the mucosa itself.

Dr. Nicloux (Paris) had studied the conditions of passage of carbonic oxide from the blood of the mother to that of the fœtus. He had employed for the determination of the quantities of the gas in the blood an accurate and delicate method elaborated in his previous experiments. When the percentage of CO in the air respired by the mother lay between $\frac{1}{10000}$ and $\frac{1}{1000}$, the quantities in the blood of mother and fœtus increased *pari passu* with increase of the percentage in the air respired, and the percentage in the fœtal blood was sensibly the same as in the maternal. With a percentage of above $\frac{1}{1000}$ of the gas in the respired air the identity of the percentage in the fœtal and maternal blood disappeared. This indicated a dissociation of the carboxy-hæmoglobin of the maternal blood at the placenta as a condition of passage across it. A simple experiment supports this view. A carp is placed in water to which has been added some oxycarbonated blood (dog's). The blood of the fish comes to contain a percentage of CO six or seven times greater than that of the medium of immersion. The animal shows no toxic effect from the immersion.

Dr. Pugliese (Bologna) had with Prof. Aducco found that the addition of sodium chloride to the water taken by fasting animals considerably increased their resistance to inanition. When the tissues of animals as similar as possible in other respects, but in the one case having water only, in the other salt and water, were analysed, the tissues under the latter condition were found to contain relatively the more water. Also the amount of water daily excreted by the animals receiving salt water was less than the amount of water excreted by those receiving water without salt.

Prof. A. Walther (St. Petersburg) demonstrated the action of Pawlow's *enterokinase* on fresh pancreatic juice as tested by digestion of measured quantities of fibrin. The conversion of the zymogen in the fresh juice into trypsin is not an oxidation process, for the *enterokinase* does not give the reactions of the oxidases, nor can the zymogen in the juice be rendered active by oxidising agents. The zymogen in the pancreatic juice is therefore not the same substance as Heidenhain's zymogen in extracts of the gland-tissue. The action of the *enterokinase* upon the zymogen is probably a hydrolytic one. From the fresh pancreatic juice a proteid (globulin?) can be precipitated

which has extraordinary tryptic but no amylolytic power; but the amylolytic power of the juice remains in the juice after removal of the tryptic proteid.

Dr. O. Cohnheim (Heidelberg) reported experiments on the disappearance of peptones placed under the influence of the intestinal *mucosa*. The peptones were not changed to albumin, but were split up into crystalloid cleavage products. This cleavage was accomplished by a ferment *erepsin* produced by the intestine, and active on peptone but not on albumin.

Drs. Delezenne and Drouin (Paris) had investigated the question of the origin of the pepsin which is secreted in urine. They found that that pepsin might have either or both of two sources, α, the pepsin secreted by the stomach and presumably reabsorbed, β, the pepsin known to exist in the muscles, salivary and other glands and organs. The authors demonstrated that the urinary pepsin had its origin in the gastric pepsin, and was obtained by reabsorption of that pepsin from the stomach itself. (1) In the dog after removal of the stomach, never under any condition of nutrition or in any digestive period is any proteolytic ferment whatever detectable in the urine. (2) In the dog after establishment of a gastric fistula and the prevention of the entrance of gastric juice into the intestine, the urine, as usual, contains pepsin. (3) In the dog after exsection of the stomach, the introduction of gastric juice into the intestine fails to result in the appearance of pepsin in the urine.

Dr. Drouin (Paris) had made observations to test the part played by the spleen (Schiff, Herzen) in pancreatic digestion. He had, in the dog, united the œsophagus to the duodenum and converted the stomach into an independent *cul-de-sac* opening on the surface by a fistula. Thus he eliminated gastric digestion altogether and left pancreatic action the chief *rôle* in digestion. He had then excised the spleen. The excision produced no appreciable difference in the assimilative powers, digestive activity or general well-being of the animal. The removal of the spleen seemed, further, in no way to alter the quality or quantity of the juice secreted by the fistulous stomach.

Prof. Gley (Paris) gave a *résumé* of his experiments and conclusions regarding the *rôle* and mutual interdependence of the thyroid and the parathyroid glands. The evidence was both chemical and histological. He regarded the parathyroids as complemental in function and structure to the main thyroid. He referred to the work done recently by Mr. Walter Edmunds (London), and a fuller summary of his communication can be found in an admirable article published by Prof. Gley recently in the English medical journals.

Prof. V. Ducceschi (Rome) communicated researches dealing with aromatic groups in the proteid molecule. Cinnamic acid could be obtained from egg-albumin and serum-albumin by a method which did not in that way split up tyrosin. It came probably from the aromatic group whence proceed in the putrefaction of some proteids phenylacetic and phenylpropionic acids; probably that group is phenyl-α-amidopropionic acid. From 500 grm. of egg-albumin, 2 grm. of β-phenylacrylic acid (cinnamic acid) are obtained.

Among other communications given in this section were those dealing with the speed of absorption and of elimination of acetylene gas by the organism (Prof. Ugolino Mosso, Genoa), the presence of lower homologues of caffeine and theobromine in certain plants (Prof. Albanese, Pavia), the pharmacodynamic action of acetyl chloride (Prof. Spineanu, Bucharest), the formation of fat in the animal body (Prof. Boruttau, Göttingen), the diastatic action of human saliva (Dr. Oehl, Pavia), the osmotic tension of milk, urine and amniotic fluid (Drs. Vicarelli and Cappori, Turin), electromotive changes observed in solutions of oxalic acid under exposure to light (Dr. Querton, Brussels), the fatty components in lecithin (Dr. Henriquez, Copenhagen), the influence of intestinal absorption on the diurnal curve of output of urea (Dr. Slosse, Brussels), the microchemistry of the cell (Dr. R. Kohn, Prague), a method for determination of the acidity of the gastric juice (Levi and Lolli, Modena), hæmolysmometry (Dr. E. Buffa, Turin).

Electrophysiology was represented, as regards special communications to the meetings of the Congress, chiefly by the papers of Profs. Boruttan, Fano, Herzen, Mislawski, Waller, Wedenskii and Weiss. The first named (Göttingen) demonstrated capillary-electrometer photograms of the action current of the frog's nerve obtained during strychnine tetanus. The frequency of the rhythm was about eight times per second, and the relative slowness of the curve was explicable by the imperfect synchronism of the course of the individual waves. Prof. Boruttan could not accept Sir J. B. Sanderson's suggested explanation of these strychnine oscillations of the electrometer line, and proposed to call them pseudotetanic. He finally entered upon the question of the proper functional rhythm of the nerve-cell.

Prof. Herzen (Lausanne) dealt with the separation of the action-current of nerve from the functional "impulse" of nerve. He appealed to, among other data, that of Boruttan's strychnine experiment, in which, from a partially dried nerve trunk incapable of transmitting the impulses from the strychnised centres to the limb-muscles, the transmission of the action-current was still demonstrably obtainable.

Dr. Waller (London) gave in two complemental reports a well-illustrated demonstrational *résumé* of the more recent of his work on the electric response of living matter, both plant and animal, to general and to adequate stimuli. New points were added to those already familiar to English students of the question. A comprehensive search has been undertaken into the distributional width of the existence of this "reaction of vitality" which he regards as coextensive with life itself.

Among points established by him were the following:—Mechanical excitation of a petiole renders the excited part electropositive to the unexcited. The illuminated part of a leaf is electropositive to an unilluminated. Electric stimulation of uninjured vegetable tissues is followed by an electrical response which is abolished at high and low temperatures, by anæsthetic vapours, and in consequence of strong electric excitation. A general relation between magnitude of response and "vitality" of plant or plant organ is noticeable, the stronger the "vitality" the greater the voltage of the response. This in seeds is confirmed by subsequent germination. Plant tissues when submitted to stimulation of uniform magnitude at regular intervals exhibit the characteristic changes known in animal physiology as "peripheral fatigue" and "recovery," "staircase effect" and summation. In consequence of one or more strong induction currents, the electrical conductivity of living plant tissues is greatly augmented. Among his observations upon animal tissues may be cited the following. The skin of the cat's foot gives an electrical response to excitation of the sciatic nerve; this current is ingoing, it has a latent period of about three seconds and an E.M.F. of a hundredth of a volt. In the skin of the frog's foot it can be shown that atropin abolishes this indirect response to excitation of the nerve. The electrical response of healthy excised human skin to electrical excitation of both directions is outgoing. Human skin continues to exhibit the outgoing response characteristic of the living state for 1–10 days after excision. Immersion in hot water at once destroys irrecoverably the power of the skin to respond. The electrical response of the skin and of the eyeball to direct excitation is comparable with similar effects witnessed in electrical organs.

Dr. Weiss (Paris) showed that if two successive electric stimuli be applied to a nerve at the same point of the nerve, the direction of the electric currents applied is important in determining the summation of the stimuli. If the electric stimuli are both of the same direction and occur within the duration of the latent period, the effect of the one is demonstrably added to the effect of the other. If they are, however, of opposite direction the stronger of the two is alone effective, at least if the weaker is subliminal it produces no obvious effect. That is, if the stronger of the stimuli is of just liminal value it remains of just liminal value whether preceded or followed by the weaker of opposite direction. The addition to it of the weaker in nowise changes the result produced by the stronger on the nerve.

Prof. Wedenski (St. Petersburg) drew attention to observations, conducted in his laboratory, indicating the fundamental similarity of inhibition of nerve to narcosis of nerve. He maintained that all general excitants of nerve exhibit three successive phases of influence upon nerve—a phase in which the rhythm of the excitation exhibits modification in the rhythm of the response, a phase in which there is a depression of conductivity of the excited state, a phase of depression of all response to excitation.

Prof. Vitzou (Bucharest) gave an account of experiments instituted to test the supposed inexcitability of the grey matter of the spinal cord to artificial stimuli. He claimed that his experiments demonstrate that the spinal grey matter, like the cerebral grey matter, is excitable by faradic currents.

Prof. Mislawski (Kasan) gave a communication upon the negative variation of reflex action. Du Bois Reymond's discovery

of the negative variation of strychnine convulsion, and Grützner's of that accompanying the spinal reflexes of the frog had shown the way to an electric examination of reflex action. His own observations exemplified how strictly the electric propagation through the reflex cell-chain conformed with the direction laid down by the Bell law of root-conduction. The electrical discharge in the reflex action he found to be an irregular one compounded of an irregular series of individual discharges.

Closely connected with such communications as these was a large group that may be classed as neurological. Prof. Langley (Cambridge) has begun an attempt to determine the group reactions to drugs and blood conditions of the different neurons which make up the nervous system. He demonstrated the stimulating action of nicotin on the neurons of the superior cervical ganglion in testimony of his view that that drug alters the cell-bodies (perikarya) of that ganglion. Since the suggestion of Carl Huber (Ann Arbor, U.S.A.) it has been customary to suppose that the incidence of action of nicotin in the sympathetic ganglia lies at the terminal fibrils of the preganglion neurons. Langley finds that if the preganglionic fibres are cut and allowed time for regeneration the local application of nicotin to the ganglion still produces its normal stimulating effect. Nicotin applied to a ganglion of the sympathetic chain causes erection of hairs only in the region supplied by the ganglion: if it stimulated the preganglionic nerve-endings axon-reflexes would move the hairs in other regions. Nicotin probably does not paralyse spinal ganglion cells; it does not stop the passage of impulses through the bipolar cells of the spinal ganglion of the skate. The erection of the hairs of the cat which occurs after asphyxia does not occur if the sympathetic pilomotor nerve-cells have been separated from the spinal cord; this blood stimulus acts, therefore, on the intraspinal pilomotor cells. Prof. Langley also spoke, in illustration of the same theme, of the effects of suprarenal extract on a number of tissues and organs where he had examined its action. His new results, together with others previously ascertained, showed that in all cases the extract produces an effect of the same kind as that produced by stimulation of the sympathetic nerve, and not like that produced by a cranial or sacral autonomic nerve. Notwithstanding this the action of the extract appears to be directly upon the tissue, not upon the sympathetic nerve-endings; thus it produces pallor and secretion of the submaxillary gland, and this after degeneration of the post-ganglionic fibres of the cervical sympathetic. The inhibitory effect of the vagus upon the cardiac sphincter of the stomach was demonstrated to the meeting.

Prof. Langendorff (Rostock) reported upon restoration of function which had occurred 105 days after total extirpation of the superior cervical ganglion of the cat. The signs of paralysis in the eye had then nearly passed off; they returned at once on section of the sympathetic nerve in the neck. Electrical excitation of the upper end of the cut nerve-trunk gave strong dilatation of the pupil, and palpebral fissure and retraction of *membrana nictitans*. Microscopical examination failed to reveal any reappearance or regeneration of the ganglion, but the sympathetic fibres must have found their way to their appropriate end-stations.

Dr. Bottazzi (Florence) reported observations on the innervation of the viscera in certain crustacea and in elasmobranchs. His communication was illustrated by a number of anatomical preparations and photograms showing the disposition of the nerve-trunks and the structure of the ganglia.

Dr. Marenghi (Pavia) demonstrated rabbits in which he had performed—as in one case was proved to the meeting by autopsy of an animal—intracranial section of the optic nerve, and still found persistence of reaction of the pupil to light and shade. The reaction was feeble and sluggish, but indubitable.

Prof. Flechsig (Leipzic) gave a very complete demonstration of preparations recording the history of the myelinisation of the nerve-fibres of the human brain. He described at considerable length, with the aid of projected slides, his views regarding the functional arrangement of different areas of the cortex cerebri. Cortical fields to the number of thirty-six, uniform in extent and distribution in different individual brains, can be mapped out by the myelogenetic method. These fields are divisible chronologically into three groups: primary 1–10, intermediate 11–31, terminal 32–36. The primary fields included the seats of cortical representation of all the senses. The myelinisation in each of the fields begins fairly contemporaneously throughout it and does not begin from a single point in it; neither the size of the nerve-fibres nor the vascularity of the tissue conditions the myelinisation of the area. Each primary field possesses a couple of well-defined conjugated tracts, one proceeding to it—cortico-petal and the earlier to myelinate—the other proceeding from it—corticofugal and the later to myelinate. The primary fields possess each a corticofugal tract which proceeds to regions non-cortical. The intermediate and terminal fields possess no such "projection" tracts. Prof. Flechsig regards both the cingulum and the fasciculus longitudinalis inferior as projection tracts from two of his primary fields; he believes, as Prof. W. H. Thompson has previously urged, that the latter tract connects the cortical visual field with the *corpus geniculatum laterale*. The intermediate fields, on the other hand, are rich in long association fibres leading to connection with other regions of the cerebral cortex.

Drs. Z. Treves (Turin) and A. Aggazzotti (Turin) reported the interesting results of an attempt to train the flight of a pigeon whose cerebral hemispheres had been removed. The bird, with another whose hemispheres were similarly removed at the same time, was allowed at first to remain, as pigeons after ablation of the hemispheres do, perched almost motionless on their wooden perch. The top of the perch offered an area some five centimetres by four. After some days it was removed from the top of the perch and placed about five centimetres from it, and was pushed towards it and in various ways incited to fly up to it. In fifteen days it began to take a short but fairly perfect flight to the perch-top. The distance was increased gradually by five centimetre increments. In five months' time by daily training the distance of flight had been extended to about eight metres. Sometimes the course of the flight was straight, often it was not so. Resting places were introduced sometimes not in a direct line to the perch in the cage. In six months' time progress had been made so far that the bird when thrown into air in a direction away from the cage orientated itself promptly and turned its flight in that direction. In nine months' time the bird flew regularly and well to the perch in the cage from any quarter of the room and when started in any direction. It, however, never once flew down from, or indeed left, its perch of its own accord, nor did it ever feed itself. From Turin it was taken to Modena for a fortnight and made to learn other exercises. On being brought back to Turin and liberated in its room it at once flew back to its cage and mounted its platform. It seemed to possess memory. The companion bird, to whom no training was given, at the end of nine months did not, when placed close to its perch and incited to fly to it, respond by flight, nor could it of itself, when placed just outside the cage, fly into the cage. Both birds retained throughout the strange huddled appearance and attitude characteristic of the pigeon after removal of the cerebral hemispheres.

Dr. A. S. Grünbaum and Prof. Sherrington (Liverpool) demonstrated a number of brains and cord-sections of anthropoid apes on which they had been investigating points in the physiology of the "motor area." Both excitation, by faradic electricity, and ablation had been employed. In view of the near approach of these brains to the configuration of the human it became obvious that the determination of the topography of the excitable and other areas must be in them of considerable practical importance to the study of human cerebral disease. They had at outset of their work been surprised to meet with results at variance with the topography generally accepted as probably obtaining in man. It had to be remembered, however, that the generally accepted topography was based chiefly on results obtained in the lower, not in the higher, apes, and that of the anthropoid apes only a single species, and that by a single specimen only, had previously been laid under experimental contribution. Their own experiments, embracing observations upon a series of chimpanzees as well as on the orang and the gorilla, were completely unanimous in denying any extension of the "motor region" to the surface behind the Rolandic fissure. Nor had they found the fissures in the motor region inexcitable, as had been asserted for the cortex of the orang, or that the motor region of the anthropoid required faradic currents much stronger than those required for the lower monkeys. A number of details were shown and dealt with in the communication, account of which limits of space preclude our here doing justice to. A chimpanzee taken to the Congress for actual demonstration of the excitation effects became ill on the journey and succumbed before experiment could be undertaken. We may remark that the research showed more clearly

than evidence hitherto accessible that in the motor region of these complexly folded higher brains the cortical fissures do not coincide with functional boundaries in the cortex, and that they do not, indeed, bear any accurately constant relation whatsoever to the functional topography. They are, with the exception of the Rolandic fissure itself, quite insecure landmarks to the details of the spatial arrangement of the functional "centres."

Prof. Nicolaides (Athens) demonstrated to the meeting two dogs in which he had performed bilateral vagotomy several months previously. He pointed out the remarkable subsidence of the symptoms that had occurred. His results, especially in regard to recovery from dyspnœic attacks, had, he contended, been considerably more favourable than those obtained by Pawlow.

Dr. Bayliss (London) gave an excellent demonstration of the antidrome vascular dilatation obtainable from the posterior spinal roots of the nerves of the pelvic limb. The excitation may be electrical, mechanical, chemical or thermal. The experiments leave no doubt that the vascular dilatation is brought about by impulses passing centrifugally along fibres of the sensory nerve-root, which, like the other fibres of that root, have their perikarya in the root-ganglion outside the cord. The fibres do not enter the sympathetic system, but proceed direct to the limb. Reflex vaso-dilatation of the limb can be produced after extirpation of the abdominal sympathetic, *i.e.* after all the vaso-constrictors have been removed; this dilatation must therefore be by means of vaso-dilator nerves which go to the limb through the hindmost three lumbar and first sacral nerves. Similarly, vaso-dilator fibres pass to the forelimb by the hindmost three cervical and first thoracic nerves.

Dr. Bocci (Siena) showed tracings demonstrating the diminution in the excitability to electric stimuli of the nerves of the frog produced by destruction of the spinal cord.

Dr. S. A. Dontas (Athens) demonstrated the different character and the greater degree of mechanical elasticity possessed by a muscle before than after poisoning by curare.

Drs. Negro and Z. Treves (Turin) demonstrated graphic records of the willed muscular contractions performed by a patient suffering from Parkinson's disease (*Paralysis agitans*). These records showed that the oscillations which, as Schäfer and v. Kries have shown, normally characterise willed contractions and normally succeed at a rate of 10–12 per second in the patient with *morbus Parkinsonii*, occur at a rhythm of only 5–6 per second.

Dr. Demoor (Brussels) showed preparations illustrating some remarkable sequelæ to trepanning in young animals. The brain had been in some way injured at the operations, yet at the end of about five months wasting of the body with epileptiform seizures ensues and death soon follows. The cells of the cerebral cortex are found to be in a condition of chromolysis with a moniliform degeneration of their dendrites.

Other communications dealt with the differential reaction of muscle and nerve (Mdlle. Joteyko, Brussels), graduation of the effects of fatigue (Mdlle. Joteyko, Brussels), the *rôle* in respiration of the sensory nerves of the diaphragm (Mislawski, Kasan), cerebellar tonus (A. Moscucci, Siena), the coordination of antagonistic muscles (Victor Henri, Paris), the phenomenon of Bell (C. Negro, Turin), conditions favourable and unfavourable to hypnosis in the frog (M. Stefanowska, Brussels). Among contributions to method may be mentioned Dr. Treves's improvements in the ergograph of Mosso, Dr. Broca's (Paris) apparatus for obtaining constant condenser discharges at any desired rate of frequency, and Dr. Corona's ingenious trephining instrument.

Among communications dealing with muscle may be cited Dr. F. S. Lee's (New York) observations with Dr. W. Salant on the influence of doses of alcohol upon the contractions of the directly excited isolated muscles of the frog. It was found that alcohol in minute doses seemed to favour the response of the muscle, in larger doses it was obviously deleterious. Dr. J. Demoor (Brussels) demonstrated his method and some of his results upon the dissociation of contraction and conduction in the muscle of the frog. The muscle is surrounded with plaster of Paris for half its length. The electrodes being placed on the free part of the muscle, a series of contractions in that free part is provoked and repeated to the production of fatigue. The plaster is then broken from the other half of the muscle and that half is found to be quite unaffected by fatigue. If the stimulating current be applied to the part within the mould instead of to that outside, the latter contracts in response to the stimulation and can be reduced to inexcitability by fatigue. But the part inside the mould, although it has served as conductor to the fatigued part, is found to have remained inappreciably affected by fatigue. Prof. Huerthle (Breslau) demonstrated a series of remarkable microphotograms of muscle fibre at rest and in contraction, examined under illumination by homogeneous light and by plane polarised light with an analyser.

Prof. Langendorff (Rostock) had examined the direction and speed of the conduction of the contraction-wave over the heart by applying to the surface of the isolated and artificially fed cat's heart two rheoscopic muscle-nerve preparations from the frog. The two preparations were 2 to 3 centimetres apart. The wave of negativity was found to sweep usually—if heart were beating well—from the base toward the apex, at a speed of 2 metres per second. If the heart were beating badly it might be as slowly propagated as ½ metre per second.

Prof. Blix (Lund) demonstrated apparatus devised for myothermal experiments on excised frog muscle; and apparatus for a similar purpose was also demonstrated by Dr. Bürker (Tubingen). Prof. Blix also showed a new form of induction excitator used by him in his more recent work on the summation of twitches.

Dr. Negro (Turin) demonstrated a fine series of microscopical specimens displaying the motor end-plates in mammalian and reptilian muscle-fibres.

Prof. Grützner (Tubingen) communicated the results of an investigation he had conducted upon the movements of the contents of the stomach and the regional distribution of the acidity of the semi-fluid mass of food occupying the cavity of the organ. The method employed had been rapid removal and freezing of the viscus and then its examination by frozen sections cut in various planes. When solid or semi-solid food is taken, that which is later introduced is always found toward the centre of the cavity of the organ. The contents of the pyloric end were always well acidified throughout, those of the cardiac end only in the layers nearest to the mucosa. The movements of the stomach seem to result in the food being deposited in layers upon the surface of the mucosa and that layer next to the mucosa being shifted toward the pylorus.

Prof. Zuntz (Berlin) described the methods employed by himself and his four colleagues, Caspari, Waldenburg, Lœwy and Kohner, in their recent research into the chemical metabolism of the body at high altitudes, namely on Monte Rosa. Dr. v. Schrötter (Vienna) reported his observations of some of the physiological phenomena attending a balloon ascent to an altitude of 7500 metres.

Of experiments dealing with the circulation, a large number were demonstrated. Prof. Hürthle (Breslau) demonstrated his new Stromuhr in action on the living animal, also a number of the graphic records obtained by it. These proved (1) increase in speed of flow of the blood in the carotid, produced by compression of the opposite carotid, (2) increase by section of the vago-sympathetic, (3) slowing of the blood stream in the crural artery as a result of tetanisation of the limb muscles by stimulation of their nerves, (4) the blood stream in the arteries as measured by the volume of blood flowing along the channel in a given time increases, not in simple proportion to increase of the arterial pressure, but in much greater ratio, *e.g.* blood pressure 87 mm. Hg., stream volume 400 mm^3., b. press. 131 mm. Hg., stream volume 1000 mm^3., b. press. 161 mm. Hg., stream volume 1500 mm^3.

Dr. T. G. Brodie (London) demonstrated a new method for investigation of effect of drugs on the mammalian heart. The mean pressure against which the heart works is kept constant and the work determined by the product of the output and of the mean pressure. An automatically working "Stromuhr" registers the output. Of the results obtained, especially noteworthy were those concerning anæsthetics. Chloroform depressed the working capacity vastly more than did ether or ethylene chloride. Suprarenal extract much increased the amount of work performed by the heart, as also its rate of beat. Suprarenal extract acts as an antidote to chloroform. If administered before chloroform it is found that the heart can withstand much larger doses of chloroform. Moreover, a heart deeply injured by chloroform will rapidly and completely recover if suprarenal extract be administered. It had in the course of the research been constantly found that the heart was very sensitive to the blood of different mammalian species, thus the heart of the dog went quickly into fibrillar incoordination unless fed with dog's blood; ox blood and other kinds of blood acting deleteriously at once. Dr. Brodie also showed his apparatus for the recording of the lung volume. He employs a plethysmographic method,

which he demonstrated in use. Dr. Dixon (Cambridge) is his collaborator in the research not yet completed, for which the apparatus was designed.

Prof. Fano (Florence) described at some length a series of electrometer photograms registering electromotive phenomena of the heart beat. The photographic records shown in illustration of several new points he brought forward were particularly fine specimens of what such records can be in the hands of the skilful.

Prof. Moussu (Alfort) had studied the lymph flow in the limbs of the larger animals (horse, ox, &c.) during physiological repose and inaction, and then under conditions of local vasoconstriction and vasodilatation and under those of general augmentation of blood pressure and of copious venous depletion. He had further observed the lymph flow under the influence of muscular work and under conditions of great activity of the tissues in general. A very large series of observations was presented in a number of tables together with diagrams of the apparatus employed for measuring the quantities of mechanical work given by the animals in certain of the experiments dealing with the effect of muscular activity. The conclusions arrived at were (1) that the lymph is not the simple product of a transudation from the blood plasma through the capillary wall under the mechanical pressure of the blood-circulation; (2) that filtration is always quite a minor factor in the production of lymph; (3) that the lymph is mainly a product of the tissues comparable to a secretion from them; (4) that the quantity of its production is in direct relation to the functional activity of the tissues; (5) that the peripheral (limb) lymphatic apparatus is in large measure an apparatus for excretion.

Prof. Stirling (Manchester) demonstrated his simple and successful method of injecting the sublingual lymph-sac of the frog and of applying drugs to the muscles related to it. Fluid, *e.g.* solution, of Berlin blue is injected under slight pressure into the dorsal lymph-sac and finds its way to the sac below the tongue. Excellent anatomical preparations are thus obtainable; drugs, *e.g.* veratrin, may thus be applied directly to the hyoglossus *in situ*.

Prof. Kemp (Illinois) on behalf of Miss Calhoun and himself made an interesting communication upon blood-platelets and their relation to coagulation of the blood-plasma. After thorough control of the method for fixing the platelets they attempted their methodic enumeration. The number varied between 961,500 and 730,000 per cub. mill. in man; a larger number than they found in dogs. The authors confirmed Bizzozero's observation that if the blood of the living dog be reduced to an incoagulable condition by repeated "whippings" and reinjections the incoagulable blood contains no platelets. But it contains some, though few, leucocytes. The authors find that in normal clotting the blood-platelets break down, the leucocytes do not. The fibrin filaments radiate from disintegrating blood-platelets at the nodes of the network they form.

Prof. Hédon (Montpellier) showed that the hæmolytic glucosides are more globulicidal in saline solutions than in serum. Substances therefore exist in the serum that may be regarded as protecting the red corpuscles against the toxicity of these glycosides. A little serum added to the water in which they are swimming protects tadpoles against the toxicity of glycosides (saponine, cyclamine) that are otherwise violently poisonous for them. Similarly, acid sodium phosphate protects the red corpuscles from the action of solanine and protects fish if added to the water of the aquarium.

The large attendance of active workers in the field of sense-organ physiology and in pyscho-physiology was a notable feature of the Congress, and the communications made upon those subjects were numerous. Dr. Tschermak (Halle) gave a lucid account of interesting and exact work upon the extent of the binocular field of vision in various vertebrate types. Prof. Hensen (Kiel) demonstrated experiments in evidence of an accommodation mechanism for the ear. Prof. Cavazzani (Ferrara) demonstrated an instrument for the estimation of the visual purple. Dr. Sante de Sanctis (Rome) reported the results of prolonged researches upon the depth of sleep. The stimulus required to break sleep was found usually to be greatest in the first half of the second hour. The increase of stimulus required to pass from provocation of a subconscious reaction to actual waking amounted on an average to three degrees of the scale of the Griessbach æsthesiometer. Prof. Osawa (Tokio) described observations indicating that most monkeys are right-handed, only a few left-handed; that birds, on the other hand, are usually left-footed. Drs. Broca and Sulzer (Paris) communicated a research into the latent period for visual acuity. Dr. S. Vaschide (Paris) had made numerous measurements of the simple reaction time for olfactory sensations. Dr. Marco Treves (Turin) reported observations on the thermo-esthesiometry of the various mucous membranes accessible to external examination. The sensitivity was in all cases found to be markedly less than is that possessed by the skin. The mucosa of the urethra and of the cervix uteri were quite incapable of heat and cold sensations, and even the cautery excited only slight, and that painful, sensation from them.

Dr. Kiesow (Turin) brought forward observations proving that the laryngeal aspect of the epiglottis is endowed with sentiency for taste, and so also the greater part of the mucosa lining the interior of the larynx itself. The whole of the soft palate (but not the hard palate) and the back of the pharynx were found endowed with taste. On the other hand, taste sensations could not be evoked from the uvula, the tonsils, the anterior or posterior pillars of the fauces. In regard to other species of sense, the uvula, tonsils and pillars of the fauces were found to be very defective in regard to touch and temperature stimuli, but fairly responsive as regards "painful"; the combination of sense-organs is in this respect almost the converse of that obtaining on inner surface of the cheek. Dr. Kiesow gave further communications upon the "temperature spots" of the skin. He laid stress upon the considerable amount of evidence that the "cold spots" lie much nearer the surface of the skin than do the "hot spots." Regarding the topographical distribution of the spots, his own very extensive observations differed in no important respect from those of Blix and Goldscheider, but in detail agreed better with those of the former, although he did find the cold spots rather more sparse than had Blix.

Dr. Kiesow also brought forward an important result for which his observations on "touch spots" gave basis, namely, that the value of the median threshold of the touch spot is within narrow limits practically the same for all touch spots the whole body-surface over. This is in strong contrast to the wide variation which the median threshold for pain exhibits. This discovery is of much significance for the analysis of spatial perception.

Among those present, in addition to those mentioned above, were Profs. Aducco (Pisa), Albanese (Pavia), Albertoni (Bologna), Axenfeld (Perugia), de Burgh Birch (Leeds), Bohr (Copenhagen), Bowditch (Boston), Chauveau (Paris), v. Cyon (Territet), Dastre (Paris), Dupuy (Paris), Ebbinghaus (Breslau), Einthoven (Leyden), Fano (Florence), Foster (Cambridge), Fredericq (Liege), Gad (Prague), Gaule (Zurich), Gley (Paris), Golgi (Pavia), O. S. F. Grünbaum (London), Héger (Brussels), Henriquez (Copenhagen), Hering (Prague), Hopkins (Cambridge), Johansson (Stockholm), Kossel (Heidelberg), Kronecker (Berne), Laulanié (Toulouse), Lépine (Lyons), Lombard (Ann Arbor, U.S.A.), Luciani (Rome), Marey (Paris), Nicolaides (Athens), Oehrwall (Upsala), Onimus (Munich), Osawa (Tokio), Perroncito (Turin), Physalix (Paris), Prévost (Geneva), Querton (Brussels), Sergi (Rome), Shore (Cambridge), Sowton (Liverpool), Stafford (Nottingham), Starling (London), Stefani (Padua), Stirling (Manchester), v. Tarchanow (St. Petersburg), Thompson (Belfast), Tigerstedt (Helsingfors), Toulouse (Paris), Tschermak (Halle), v. Uexkull (Naples), Verworn (Göttengen), Vintsgau (Innsbrück), Welby (London). The Congress was more numerously attended than any previous one. The courtesy and hospitality of their Italian colleagues will always remain a memory with the members present. The Italian committee consisted of Profs. Aducco, Cavazzani, Corona, Fano, Luciani, Angelo Mosso, Patrizi, Sertoli and Stefani. Drs. Treves and Herlitzka proved indefatigable local secretaries. The Italian language was an official language for the Congress, and it was formally decided that it should henceforth remain so.

ON A LATE PLEISTOCENE DEPOSIT CONTAINING MAMMOTH.

AMONG the districts in which there is a fair probability of obtaining satisfactory evidence as to the sequence of events which have occurred since the glacial episode, there is none more promising than the northern part of East Anglia, nor is there any region where the history of that early post-Glacial age, if it could be clearly made out, would throw light upon so many vexed questions in geology.

It is therefore very desirable that any new bit of evidence bearing upon the case should be placed on record, and, from this point of view, a discovery recently made at Didlington Hall seems to be of value, especially as the conditions which it indicates are exceptional in the district and the facies of the animal remains found is unusual. The bones and shells were carefully collected by Lady Amherst and are now preserved in the museum at the Hall.

Didlington Hall is built on the margin of an extensive bed of Boulder Clay, into which the river has cut back, forming a cliff which now rises from 26 feet, the level of the water in the lake, to about 38 feet above ordnance datum. It is no longer seen as a cliff just here, because the original form of the ground has been much modified by natural and artificial operations. Down the valley, however, this cliff forms a well-marked feature along the right bank, but up stream it is generally softened down into a gentle slope. Owing to the overlap of the artificial soil and rainwash near the Hall, nothing was known of the character of the marginal deposits of the river until, in carrying out some alterations in the boat-house, it was found necessary to cut off and dry a portion of the bed of the lake and remove some of the clay close to the original bank.

The lowest part of the bed was full of large stones out of the Boulder Clay, most of them covered with glacial striæ. With them were the bones of large animals which had probably been also washed in from the bank in floods. It appeared to be a deposit thrown down in an embayed curve of the river, perhaps even cut off from the stream so as to form a pond or "broad." The velocity of the stream cannot have been great, for the rest of the deposit consisted of fine blue mud and the shells were well preserved, as were also the plant remains, though these were very fragmentary. There were, moreover, no signs of sorting by water in any part of the deposit exposed, which was not more than 18 inches or two feet in thickness. The river must have been diverted or its velocity somehow checked and this small patch left as a record of some of its latest efforts in this part of the valley.

This clay was covered by a few feet of later deposits from the existing lake, and was penetrated by the roots of water lilies and other aquatic plants.

The following shells were found in it and determined by Mrs. McKenny Hughes:—*Sphaerium Corneum*, Linn., *Pisidium amnicum*, Müll., *P. fontinale*, Drap., *Unio sp.* fragments only, *Bythinia tentaculata*, Linn., *Valvata piscinalis*, Müll., *Planorbis carinatus*, Müll., *Limnaea peregra*, Müll. (several varieties), *L. auricularia*, Linn. (and varieties), *L. stagnalis*, Linn., *L. palustris?* Müll., *Succinea putris*, Linn., *Helix* (*Fruticicola*) *hispida*, Linn., *H.* (*Xerophila*) *Ericetorum*, Müll., *Pupa marginata*, Drap. The larger animals were:—*Elephas primigenius*, *Equus caballus*, *Bos longifrons*. *Cervus elaphus* of very large size has been found in a similar deposit in the immediate neighbourhood.

We notice the absence of the older forms of Bos, viz. *Bison priscus* and *Bos Urus*; whereas a strain of *Bos longifrons* occurs here, though it has never been found associated with the mammoth in the gravels.

Bos longifrons has not yet been satisfactorily described. There is certainly a larger and a smaller variety in the peat of both Ireland and England, but whether they were wild or all domesticated or derived from a domesticated breed is not clear.

It may be that further search would yield some of the forms whose absence we remark, but the evidence, so far as it goes, points to the Didlington Clay being more recent than the gravels in which the mammoth occurs elsewhere in East Anglia. It might be, of course, that it was made up of the washings of earlier deposits of various age, but there is nothing in the condition of the mammoth bones to suggest that they are not of the same age as the other remains found here. Moreover, several consecutive vertebræ of the mammoth found together in their natural order prove that the ligaments had not perished when the bones were buried in the clay.

Some of the bones, especially those of horse, were grooved and striated in such a manner as to remind one of ice action, and of course the close proximity of the Boulder Clay suggested the possibility of their being derived from it; while we have to bear in mind also the probability of the agency of river ice at a later period.

On the other hand, similar striæ on the bones found in other sections in East Anglia have undoubtedly been caused by settlements in the stony mass by which the gravel has been squeezed against and even into the inside of the bones while the process of decomposition was going on. This fact and the occurrence of similar striæ on the bones of saurians in Jurassic clays throw great doubt upon the inference that the scratches on the Didlington bones are due to any kind of ice action. None of the plant remains have been determined.

There is much evidence in favour of the view that after that not so very remote yet very exceptional episode, in which glacial conditions prevailed over this area, the whole of the district stood at a higher level. Then the basin of the Wash and its tributaries was re-excavated and extended, and a considerable resultant river found its way into the sea through the chalk escarpment between Hunstanton and Skegness. Into this river the Wissey and other streams of west Norfolk found their way. Some time later the area was depressed, and the rivers, which had descended with considerable force, especially in times of flood, were met by the tides at higher and higher points as their valleys gradually sank to sea-level. But this was not a sudden or even a rapid change, and the species of plants and animals disappeared by degrees as the conditions became unsuited for them. The Didlington Clay belongs to this period of changing conditions and is a late Pleistocene formation laid down after the arrival of *Bos longifrons*, but before the mammoth had ceased to inhabit, or at any rate to be a visitor in, the district.

Almost all the remains of the earlier Pleistocene times have been obtained from sands and gravels of a torrential character, and we have seldom had any opportunity of examining the embayed corners where they have been preserved in fine mud. This is partly due to the fact that the sand and gravel are of commercial value, but the mud is only excavated to get at something below it, as, for instance, at the marl for cement, or the gault for bricks, or, as in the case to which attention is now called, where the excavations were made for a new boat-house which exposed this blue river clay at Didlington Hall.

But another, and perhaps the more common, reason is that it was generally near the mouths of the sinking river valleys which have been since submerged and buried under later deposits that the velocity of the stream was checked so as to allow of the deposition of fine mud instead of sand and gravel.

T. McKENNY HUGHES.

SOME SEASONAL VARIATIONS IN THE BRITISH ISLES.

IN a paper just published by the Royal Society[1] attention is directed to a peculiarity in the seasonal variation of temperature in the British Isles disclosed by the resolution into harmonic components of the curves of day to day variation derived from the 25-year means of the 24-hourly readings at Kew, Falmouth, Aberdeen and Valencia. The peculiarity in question is the second harmonic component which is represented by a curve with two maxima and two minima in the year. In the 25-year curves for each of the observatories the maxima of the second components come within four days on either side of January 31 and August 1 respectively, and the minima are in the first week of May and November. They represent a temperature effect which exaggerates the height and shortens by nearly two weeks the duration of the summer portion of the compound curve; it also moderates the depth and lengthens by an equal amount the duration of the winter portion. The effect has a range of nearly 3° F. at Kew in the 25-year mean curve, out of a whole range of 24° F. Its magnitude at the other stations is approximately the same fraction of the whole range at those stations. It is much larger in curves for single years at Kew, but the epoch varies somewhat. It is called meteorological, as distinguished from planetary, because in the mean curves for the Continental stations Vienna and Agra it is quite different either in magnitude, or epoch, or both.

An attempt is made to account for this peculiarity by the prevalence of winds from different quarters at different times of the year. The mean temperatures of 3288 successive days (nine years) at Kew are grouped according to wind direction from eight compass points or, more strictly speaking, according to the direction at right angles to barometric gradient. The method

1 "On the Seasonal Variation of Atmospheric Temperature in the British Isles and its Relation to Wind-direction, with a Note on the Effect of Sea Temperature on the Seasonal Variation of Air Temperature." By W. N. Shaw, F.R.S., and R. Waley Cohen. Read before the Royal Society, June 20.

of reference of the temperatures is unusual. The temperature for any day is not referred to the ascertained 25-year mean for that day, but to the corresponding point of the first component in the harmonic resolution of the 25-year curve, and it is the differences from this standard which are considered. To obtain trustworthy means for the several winds the differences for each ten days of the year or for each month are grouped, and the winds are also grouped according to their average annual effect upon temperature, which is tabulated in the paper. Thus N., N.E., and E. winds (E., S.E. and S. gradients) are grouped as "cold winds," S., S.W. and W. winds as "warm," and N.W. and S.E. as "temperate."

A series of diagrams exhibits the results obtained, and it is noteworthy that the chief characteristics of the peculiarity which it is sought to explain, viz. maxima of warming effect in January and July with maxima of cooling effect in May and November, are traceable in different ways in the temperature curves for separate winds and still more markedly in those for the groups of winds. Thus the peculiarity is only partly attributable to the prevalence of warm or cold winds; part is due to a similar peculiarity in the seasonal variation of temperature of the individual winds themselves. Thus the May minimum is shown to be due partly to the special prevalence of "cold winds" and partly to the relative coldness of those winds at that season: the corresponding November minimum is attributed to the prevalence of "temperate winds" and the exceptional coldness of those winds at that period of the year. The July maximum corresponds to the exceptional warmth of the usually cold or temperate groups of winds and the January maximum corresponds especially to the frequency of occurrence of "warm winds."

The half-yearly component of the variation of temperature in individual winds remains unexplained, but the following facts are noted in connection with it: first, a similar effect is found in the temperature variation of sea-water at stations surrounding these islands and, secondly, a similar second order component with similar epoch is found in the seasonal variation of the barometric gradient between London and Valencia and still more conspicuously in the barometric gradient between London and Aberdeen.

The data as to the relation between wind, or gradient, and temperature have been obtained for Kew only.

The paper also contains an account of the variation of temperature with the type of weather prevailing, whether cyclonic or anticyclonic, and it is shown that the effect in question cannot be ascribed to the differences of frequency of these types at different seasons.

To the paper is appended a note on the effect of sea temperature upon the seasonal variation of air temperature. In this an attempt is made, by the application of the principle of the vector composition of sine curves of the same period but with different epochs, to resolve a resultant annual temperature oscillation into components corresponding to the "original oscillation" and the superposed effect of sea or land. By the application of the principle in the case of Kew, it is shown that the amplitude of the "original oscillation" at Kew cannot be less than 5·3° F. and the effect of the surrounding sea corresponds to an oscillation which cannot exceed 8·3° F. in amplitude. The resultant oscillation at Kew ought, however, to be resolved into three components—the original component, that due to the surrounding land and that due to the sea; but there are not sufficient data to determine them directly.

Application is also made of the same principles to the resolution of the temperature variation at Scilly and at a station in Siberia. The numerical results are not to be regarded as final on account of the inadequacy of the data used.

RESEARCH IN UNIVERSITY EDUCATION.

THE development of higher education in the direction of research was the keynote of the address delivered by Prof. J. G. Macgregor, F.R.S., at the University of Edinburgh on October 15, in opening the Natural Philosophy Class as the late Prof. Tait's successor. Research methods should be used in education from the Kindergarten to the University; because the spirit of self-help, of inquiry and of inventiveness which they encourage is at the foundation of all progress in science and industry. When science began to be studied in our schools and colleges about forty years ago, the schoolmen of the day followed, with few exceptions, the methods which they used in teaching the humanities. Lectures and books provided the material and examinations the test of retentivity. The system was fundamentally wrong when applied to science though sound for studies of literature. Investigation is necessary in both cases if progress is to be made, but, as Prof. Macgregor remarks, "while in science the outfit of the laboratory consists of apparatus and tools, in language it consists of the text and the lexicon."

The neglect of the spirit of research in the study of science is largely responsible for the want of public sympathy with work of investigation and the inadequacy of provision made for it. Nations like those of America and Germany which have recognised that research is not only an educational discipline but exercises a powerful influence upon industrial development, now take the initiative where we were once the leaders. Formerly, it was necessary for the young American to go to Germany to obtain the pioneer spirit, but the need no longer exists, for the leading universities of the United States have been remodelled on modern lines. In Great Britain the conservative spirit prevails and has prevented the course of university development demanded by the requirements of the age. The characteristic attitudes of the German, American and British peoples are as old as the prophets, from whom Prof. Macgregor derives an appropriate illustration.

"The German," he remarks, "may be said to have sought wisdom for her own sake as being more precious than rubies, and he is finding now that she has length of days in her right hand, and in her left riches and honour. The American, though he sought her not, heard her crying at the gates: I, Wisdom, dwell with prudence and find out knowledge of witty inventions; and having heeded her cry, he too is reaping his reward. We Britons have neither sought her for her own sake nor heeded her cry, but have said to ourselves: There is no new thing under the sun. He that increaseth knowledge increaseth sorrow, and much study is a weariness to the flesh. The sleep of the labouring man is sweet. Yet a little more sleep, a little more slumber, a little more folding of the hands in sleep. And now we fear that poverty is coming as one that travelleth, and want as an armed man."

It is the duty of those of us who are awake to national necessities to exert ourselves in the endeavour to arouse the British people to action, and our political leaders to a sense of responsibility for future welfare. More liberal provision must be made for the increase of knowledge, and men who devote themselves to research must be prized as highly as those who have contributed in other ways to the progress of the nation. There must be increase of funds and increase of freedom in the universities and the guiding principle of the work must be research. Prof. Macgregor emphasises these points in the following concluding part of his address.

Research is costly. It means increased teaching staff and adequate provision of all the requisite appliances. Much good work, it is true, may be done with a comparatively small outfit; but to obtain the best result, the outfit, if not lavish, must at any rate be generous. And as the importance of research by students has never been recognised amongst us, the present outfit is meagre.

It will perhaps occur to most of you that the princely gift of 2,000,000*l.* which Mr. Carnegie has made to the Scottish people for reducing the cost of the higher education and increasing its efficiency may be drawn upon for the present purpose, and may be sufficient. Doubtless it will be drawn upon, but it will certainly not be sufficient. When we think of the number of colleges which are to be assisted, and of the number of different departments in each, we see at once that the amount which any one department may expect to receive must be comparatively small. The moiety of the Carnegie fund which is devoted to equipment would build, equip and maintain perhaps about twenty laboratories of the more expensive kind such as are required in the various sciences and in their numerous applications. It becomes obvious, therefore, both how munificent a gift the Scottish people have received, and, since each university ought to possess many of these laboratories, how inadequate it is for the introduction of research study into the various departments of university work.

In Germany the nation itself provides for research, and does so generously, because it is, and has long been, an investigating nation. We are not; and if we introduce research into our universities it will be because, like the Americans, we have

come to recognise its educational and industrial importance. It will be individuals who will lead in this recognition; and we must therefore rely, as the Americans have done, mainly on the public spirit of citizens. The reports of the United States Commissioner of Education show that there has been in recent years a steady increase, year by year, both in the benefactions and in the Government grants which the universities and colleges have received, culminating in 1898-9 (the date of the latest report) in benefactions amounting to 4,400,000*l.* for that one year, and Government grants amounting to 1,500,000*l.*—facts which fully explain how it is that the great universities, which, of course, have been receiving the lion's share, have been able to build up, in a comparatively short time, well-equipped research schools in many departments of study. If we are to do the same, we must not rest satisfied with the equipment which the Carnegie fund can provide, but must supplement it with a liberality which, if not individually so princely as Mr. Carnegie's, will collectively exceed it in amount.

And here let me suggest that the endowment of research in Natural Philosophy in this university might well form the first instance of such enlightened liberality. Tait needs no effort of ours for the perpetuation of his name. By his scientific work he has raised for himself, as a distinguished leader in the advancement of knowledge, a more lasting monument than any that we could erect. But of his services to the University and the State there is no memorial. There are thousands of his students who have drunk from the well of his inspiration and been made stronger men by the draught. There are tens of thousands of his fellow-citizens whose pride in the Scottish metropolis has received new justification from his whole-souled devotion to its maintenance as a centre of light and leading. Is it too much to expect that they should found a research laboratory bearing his name, and thus appropriately mark their appreciation of a great Scotsman who showed by the exercise of his own creative power that Britain at least shares in the intellectual leadership of the world, and by the cultivation of creative power in his students did what he could to maintain her industrial leadership as well?

There would be little advantage in the possession of research funds, however, without full freedom to use them; and at present they could be used only to a limited extent. Research work is recognised in our universities as qualifying for certain high degrees, so high that no one is supposed to be fitted for them until five years have elapsed from the date of his having become a Master of Arts or a Bachelor of Science, so high consequently that they are taken only by the few. It is not recognised as qualifying for the M.A. and B.Sc. degrees themselves, and any time which may be spent by an undergraduate in investigation is thus condemned by our regulations to be, so far as the degree is concerned, "time elaborately thrown away." Nor is it easy to gain full freedom to teach by research; for when we ask how the recognition of research study in the undergraduate courses is to be obtained, we find that changes in regulations can be made only with the concurrence of the Scottish Universities Committee of the Privy Council, and that it is hopeless to expect the concurrence of this Committee unless it is asked for by at least two universities. It will at once be obvious that the advocate of reform has an arduous task. For he must persuade in succession his own university, a second university, and the Privy Council Committee. And this procedure is requisite, not merely to secure the desired recognition of research study, but to carry out any large measure of reform. It has obviously been devised with the object of preventing hasty and ill-considered change on the part of any of our universities, and any change whatever which does not commend itself to more than one. It may be admitted at once that it is admirably suited to the purpose; for if we think of the correspondence involved in the advocacy of any reform, the iteration and reiteration of argumentation, the button-holing, perhaps even the lobbying and "log-rolling," it becomes apparent that no better system could be devised to dampen the enthusiasm of the reformer and to perpetuate things as they are.

It is perhaps improper in one who has only recently joined your staff of teachers, and may not be fully acquainted with the advantages of the organisation referred to, to express any decided opinion about it. But, as an old student, who for years has been watching the course of his Alma Mater from afar, and is thus in a position to let you see yourselves as others see you, I may allow myself to say that the Ordinances of the Scottish Universities Commission and the authority of the Privy Council Committee seem to me to be millstones about the necks of the Scottish universities, which, unless the universities have a supernatural buoyancy, must sink them lower and lower relatively to the progressive universities of the world.

The most important condition of the steady progress of the German university has been the *Lehrfreiheit*, and the corollary insisted upon by the universities and recognised by the State, that when the best available teachers have been selected they must be supposed to know better than any external committee what is to be taught and how the teaching is to be done, and that consequently they must be free to regulate and modify their teaching as knowledge advances and as methods are improved.

And, similarly, one essential condition of the progress of the American university has been its autonomy. Johns Hopkins University, non-existent twenty-five years ago, is to-day one of the leading universities of the world, because it put at its head a talented educational reformer and gave him a free hand; and in consequence of a similar policy, Harvard, in the last quarter of a century, has been transformed from being a leading American university to being a leading world's university. These two great institutions work on quite different lines. Had either required to persuade the other of the value of its organisation and then to persuade a Committee of Congress, it is safe to assert that the extraordinary development which both have exhibited would never have occurred.

The question of the relation of the universities to the Privy Council Committee, of the advantages of individual as opposed to collective development, of the kinds of change which ought to be capable of being made from within, and the kinds which ought to be submitted to an external tribunal—these are questions of too great complexity to be discussed in the last paragraphs of an address. But when the introduction of research work into the undergraduate courses is found to be among the reforms which must wait for collective action and the consent of an external body, it becomes obvious, I think, that the line between changes which may be made from within and changes which require approval from without has been so drawn as to hamper unduly the development of our universities, and that it requires to be redrawn in the spirit of progress.

Meantime, as to the particular change which I am advocating to-day, we need not despair. Reform in this direction is in the air. Under the stress of the national industrial crisis and the growing conviction that something must be wrong in our educational system, those educationists who have long advocated it are securing to-day an attention such as they have never before received. And when we find the Chancellor of the University of Birmingham, a leading Cabinet Minister, eager to introduce research into his university, and the chairman of the Educational Section of the British Association, our Minister of Education, as eager to introduce it into his schools, we are encouraged to hope that at no distant date the movement may be fully developed which was inaugurated in this university through the profound educational insight of Prof. Tait, and that all our universities may be enabled to exert the stimulating influence that schools of the higher education should do, not merely on industrial development, but on all forms of progressive activity.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

CAMBRIDGE.—The Financial Board has published a proposal that the University should purchase some six acres of land belonging to Downing College, and adjoining the new buildings for geology and botany. The site is practically the only one now available for the extension of the museums, and it will, if not secured by the University, be divided up by new streets for ordinary building purposes. The price is about 25,000*l.*, which, in the absence of benefactions, will have to be raised by loan.

Dr. Anningson, Dr. Collingridge, Prof. Woodhead, Mr. J. E. Purvis and Dr. Tatham have been appointed University examiners in sanitary science.

At a meeting held under the auspices of the Philosophical Society on November 18, it was decided to invite the British Association to visit Cambridge in 1904 or 1905.

MR. CARNEGIE has announced that he will give 400,000*l.* more to Pittsburg, half to the Carnegie Institute and half to the new technical school, the building of which will shortly be commenced.

FROM the Report of the Somerset County Education Committee we learn that an experimental farm has been established under the auspices of the committee at Bickenhall, near Taunton, where systematic observations are made and experiments conducted on the breeding, feeding and produce of farm animals, more especially those usually found on a dairy farm. Experiments are also made on the production of various crops.

THE annual meeting of the Association of Headmasters of Higher Grade Schools and Schools of Science was held on Friday last at the rooms of the Society of Arts. Mr. E. J. Cox, Headmaster of the George Dixon Higher Grade School, Birmingham, delivered his presidential address, taking for his subject the recent return of the Board of Education, which gives statistics relating to schools of science in connection with board schools and certain conclusions which have been drawn from the return by a section of the Press. Mr. Cox, and the association over which he presides, maintain that these schools of science are providing a thorough and suitable preparation for boys who will later proceed to workshops and factories. Judging by the remarkable unanimity of the reports of the inspectors of the Board of Education, South Kensington, it may certainly be said that these schools provide the best preparation for the later work of the technical school to be obtained in this country. It is to be hoped that future legislation will provide a place in the national system of education for schools of this character, since they effectually ensure that the brightest children of the elementary schools shall receive practical instruction in the methods of science. It is a hopeful sign for the future of English education that several representatives of different trade societies were present at the meeting and showed by their speeches that they understood the value of a knowledge of science to all engaged in manufacture.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Astronomical Society, November 8.—Dr. J. W. L. Glaisher, president, in the chair.—Mr. S. A. Saunder read a paper on the determination of selenographic positions and the measurement of lunar photographs. This was a second paper on the subject, dealing with the determination of a first group of standard points on the moon, by measures made at the telescope and on photographs. Prof. Turner said this was a work in which those could assist who possessed telescopes of moderate aperture, as it had been found that very large apertures were unsuited for measures of the lunar surface.—Father Sidgreaves read a paper on the spectrum of Nova Persei from February 28 to April 26; with an appendix, dealing with its spectrum in August and September. Photographs were shown of the spectrum taken at Stonyhurst on August 27 and September 5, when it had become a bright-line spectrum, some of the lines remaining very broad and well defined.—Mr. A. R. Hinks gave an account of the experimental reduction of some photographs of Eros made at Cambridge Observatory for the determination of solar parallax; he explained the methods employed and gave some preliminary results.—Mr. H. C. Plummer read a paper on periodic orbits in the neighbourhood of centres of libration.—Mr. Bellamy read his paper on the place of the variable star RU Herculis and the neighbouring stars from photographic measures.—Prof. W. W. Campbell, Prof. J. Scheiner and M. Ch. Trépied were elected associates of the Society.

Linnean Society, November 7.—Prof. S. H. Vines, F.R.S., president, in the chair.—Mr. W. Botting Hemsley, F.R.S., on behalf of the Director of the Royal Gardens, Kew, exhibited the following specimens:—(1) A West Australian umbelliferous shrub, *Siebera deflexa*, which produces tubers, called *Yuke* by the aborigines, who eat them both raw and cooked. Many shrubs in dry countries form large tuberous stocks from which annual stems spring; but the tubers of *Siebera deflexa* grow in strings showing no trace of eyes or buds, but scars where stems may have been detached. Whether independent plants spring from the separate tubers is a question which remains to be determined. (2) Germinating seeds of *Araucaria Bidwillii*, received from Grahamstown. The peculiarity in the germination is that there are two distinct stages; in the first stage the radicle emerges from the shell of the seed, eventually bringing out the petioles of the cotyledons and the axis of the plantlet. The radicle grows into a carrot-shaped woody body, from which the petioles of the cotyledons disarticulate, leaving a few minute rudimentary leaves forming the point of the plumule. After some weeks the second stage begins with the elongation of the plumule, which eventually becomes the trunk of the tree. It appears that the second stage may be delayed a considerable time without loss of vitality. The germination of the seeds of *Araucaria Bidwillii* had been previously observed, and the process has been described and illustrated in Regel's "Gartenflora," 1865, p. 103; but the two stages of growth escaped notice. Another peculiarity is there pointed out: each seed contained two or more embryos, which germinated and grew so that 164 plants were raised from seventy-five seeds. *Araucaria Bidwillii* is the *Bunya-bunya* of Queensland, and the seeds were formerly an important article of food of the Australian aborigines. (3) A drawing of *Archidendron solomonensis*, a new pluricarpellary leguminous tree, native of the Solomon Islands, where it was discovered by Archdeacon Comins. In this instance there were three ripe pods developed from one flower; and it was explained that in the flowering stage there were usually eight carpels; but they probably rarely, if ever, all reach maturity. The genus Archidendron was founded on an Australian species, and since then several other species have been discovered in New Guinea and the adjacent islands. (4) A selection of South African species of Helichrysum showing the great diversity in habit, foliage and flowers displayed by this very large genus of Compositæ.—Dr. Rendle showed germinating seeds of *Crinum longifolium*, received from Mr. E. A. Bowles, as an example of the so-called bulbiform seeds which characterise this and some other allied genera of Amaryllideæ.—The president directed attention to a specimen of *Luzula nivea* from a cultivated plant of unusual dimensions.—Mr. Cecil Warburton, on behalf of Miss Alice Embleton and himself, read a paper on the life-history of the black currant gall-mite, *Eriophyes* (*Phytoptus*) *ribis*, hitherto very imperfectly known, and dealt particularly with its behaviour during the migration-period, which lasted from the middle of May to the middle of June. Its natural enemies and its relation to the red currant plant were also discussed.—Mr. C. B. Clarke, F.R.S., communicated some notes on the types of species of Carex in Boott's Herbarium.

CAMBRIDGE.

Philosophical Society, October 28.—Mr. J. Larmor, vice-president, in the chair.—Prof. A. Macalister was elected president for the session 1901–2.—Notes on minerals from the Lengenbach Binnenthal, with an analysis by Mr. H. Jackson, by Mr. R. H. Solly (see vol. lxiv. p. 577, October 10).—Some remarks on the notion of number, by Dr. Hobson.—The Hall effect in gases at low pressures, by Mr. H. A. Wilson. The experiments described in this paper were undertaken with the object of detecting and investigating the Hall effect in the positive column of the ordinary electric discharge at low pressures. A vacuum tube was constructed having two small electrodes 6·5 millimetres apart, attached to a stopper ground into a side tube, joined on at right angles to the main discharge tube. By rotating the stopper the two small electrodes could be made to lie both in the same equipotential surface of the positive column. The difference of potential between these electrodes was measured by means of a quadrant electrometer, and the stopper was turned until the electrometer deflection was zero. A magnetic field was then applied perpendicular to the line joining the two small electrodes and to the direction of the discharge. It was found that the field produced a difference of potential between the small electrodes which appeared to be a true Hall effect and was proportional to the magnetic field. In the uniform positive column this transverse potential gradient was found to be nearly independent of the current through the tube and inversely proportional to the pressure of the air in the tube. At 1 millimetre pressure the difference between the velocities of the negative and positive ions due to one volt per cm. was found to be $14 \times 10^4 \frac{\text{cms.}}{\text{sec.}}$.—On some problems in electric convection, by Mr. G. T. Walker. The paper deals with problems involving the motion of electrified particles through dielectrics which are themselves in motion relative to the ether. It is shown that if space on one side of an infinite plane be occupied by a dielectric and this medium be moving at righ angles to its bounding plane, the determination of the electric and magnetic forces due to a point-charge possessed of a velocity

in the same direction can be effected: the images are moving point-charges. Attention is drawn to the inequality of the action and reaction in some of these cases, and the results are shown to be consistent with expressions obtained for the energy of the field.—On some phenomena connected with the combination of hydrogen and chlorine under the influence of light, by Mr. P. V. Bevan. When light of sufficient intensity acts on a mixture of hydrogen and chlorine in equal proportions the first effect observed is an increase in the volume of the mixture. This is shown to be due to a rise in temperature caused by the heat evolved in the formation of hydrochloric acid. It is also shown that the fall in temperature of the gas mixture to that of the surrounding medium accounts for the observed decrease in volume after light ceases to act on the mixture.

MANCHESTER.

Literary and Philosophical Society, November 12.—Mr. Charles Bailey, president, in the chair.—Mr. W. B. Faraday showed a stone adze, one of several similar implements which have been found, from time to time, near Leek. He suggested a comparison with the Eolithic stone implements which were recently shown to the Society by Mr. R. D. Darbyshire.—Dr. Charles H. Lees described the Hampson air-liquefying apparatus presented to the physical laboratories of the Owens College by Sir Henry E. Roscoe. After explaining the principle on which the action of the apparatus depends, and describing the experiments of Joule and Thomson which led to the discovery of that principle, Dr. Lees gave a *résumé* of the present state of knowledge of the properties of liquid air and of other bodies when cooled down to the temperature of liquid air.

PARIS.

Academy of Sciences, November 11.—M. Bouquet de la Grye in the chair.—Extract from a letter of M. Jansson, noting the successful results of the eclipse expedition at Cairo (see p. 62).—On a new method of manipulating liquefied gas in sealed tubes, by M. Henri Moissan. Since solid carbonic acid can now be readily obtained, experiments were made with various liquids as solvents to see what temperatures could be reached, the evaporation being increased by a current of dry air. Of the liquids tried, methyl and ethyl alcohols, methyl chloride, aldehyde, acetic ether and acetone, the last named proved to be the best, a temperature of $-98°$ C. being obtained by its means. If the current of dry air is previously cooled to $-80°$, the second mixture of acetone and carbon dioxide reaches $-110°$ C. Details are then given of the best method of storing pure gases in the liquid form in sealed tubes, and of the precautions necessary.—On the action of the metal ammoniums upon hydrogen sulphide, by M. Henri Moissan. At a temperature between $-75°$ and $-70°$ liquid sulphuretted hydrogen reacts upon lithium-ammonium, giving a sulphide of lithium-ammonia and free hydrogen. The molecule $(NH_4)_n$, if it is produced in this reaction, is not stable at this low temperature and splits up into ammonia and hydrogen. The reaction with calcium-ammonium is similar.—On the origin of the starch in the grain of wheat, by MM. P. P. Dehérain and C. Dupont.—On the absence of electric displacement during the movement of a mass of air in a magnetic field, by M. R. Blondlot. The experiments described were undertaken with a view of deciding between two opposed theories. It was found that in air there is no displacement; this is contrary to the theory of Hertz on the electrodynamics of bodies in motion, but is in agreement with the theory of H. A. Lorentz.—On rational differential equations, by M. Edmond Maillet.—On the number of roots common to several equations, by M. A. Davidoglou.—A new method for the study of microphonic currents, by M. A. Blondel. The amplitude of the oscillations is increased by a suitable resonator, and a bifilar oscillograph used giving deviations of several millimetres for one milliampere. A diagram of the curves obtained with the five vowels accompanies the paper.—On the formation of ozone, by M. A. Chassy. A given volume of oxygen was submitted in an ozoniser to a current of known intensity. It was found that the law of increase of ozone was the same whatever the intensity of the electric current. A feeble current always produced the same effect as an intense current, provided that it acted over a time sufficiently long, or that the flow of the gas was sufficiently slow.—The application to man of the regeneration of confined air by means of sodium peroxide, by MM. A. Desgrez and V. Balthazard. A description of the improvements in detail of an apparatus previously described.

DIARY OF SOCIETIES.

THURSDAY, NOVEMBER 21.

ROYAL SOCIETY, at 4.30.—On Skin-currents. Part II. Observations on Cats: Dr. Waller, F.R.S.—The New Biological Test for Blood in relation to Zoological Classification: Dr. G. H. F. Nuttall.—On the Inheritance of the Mental Characteristics in Man: Prof. K. Pearson, F.R.S.—Observations on the Cerebral Cortex of the Ape (Preliminary Communication): A. S. F. Grünbaum and Prof. Sherrington, F.R.S.—On the Process of Hair Turning White: Prof. E. Metchinkoff, For.Mem.R.S.

LINNEAN SOCIETY, at 8.—Report on the Botanical Publications of the United Kingdom as a Part of the International Catalogue of Scientific Literature: B. Daydon Jackson.

CHEMICAL SOCIETY, at 8.—On the Oxidation of Sulphurous Acid to Dithionic Acid by Metallic Oxides: H. C. H. Carpenter.—Optically Active β-hydroxybutyric Acids: A. McKenzie.—On the Hydrochloride of Thiocarbamide: H. P. Stevens.—The Constituents of the Essential Oil of *Asarum Canadense*: F. B. Power and F. H. Lees.—Note on the Reduction of Trinitrobenzene and Trinitrotoluene with Hydrogen Sulphide: J. B. Cohen and H. D. Dakin.

INSTITUTION OF ELECTRICAL ENGINEERS, at 8.—Presidential Address.

FRIDAY, NOVEMBER 22.

PHYSICAL SOCIETY, at 5.—(1) Multiple Transmission Fixed Arm Spectroscopes; (2) On the Measurement of Young's Modulus: Prof. W. Cassie.—Notes on Gas Thermometry, Part II.: Dr. P. Chappuis.

MONDAY, NOVEMBER 25.

ROYAL GEOGRAPHICAL SOCIETY, at 8.30.

SOCIETY OF ARTS, at 8.—Chemistry of Confectioners' Materials and Processes: William Jago.

INSTITUTE OF ACTUARIES, at 5.30.—The Case for Census Reform: G. H. Ryan.

TUESDAY, NOVEMBER 26.

ANTHROPOLOGICAL INSTITUTE, at 8.30.—Exhibition of Palæolithic Implements from Savernake: E. Willett.—Exhibition of "Totem" Stones, collected by the Hon. A. Herbert: N. W. Thomas.—Dwarf Flints from the Sand Mounds of Samthorpe: Rev. R. F. Gatty.

INSTITUTION OF CIVIL ENGINEERS, at 8.—Train Resistance: John A. S. Aspinall.

WEDNESDAY, NOVEMBER 27.

SOCIETY OF ARTS, at 8.—Leather for Bookbinding: Dr. J. Gordon Parker.

THURSDAY, NOVEMBER 28.

ROYAL SOCIETY, at 4.30.

INSTITUTION OF ELECTRICAL ENGINEERS, at 8.

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THURSDAY, NOVEMBER 28, 1901.

PUBLIC HEALTH ADMINISTRATION IN AMERICA.

Municipal Sanitation in the United States. By Chas. V. Chapin, M.D., Superintendent of Health of the City of Providence. Pp. viii + 970. (Providence, R.I.: Snow and Farnham, The Providence Press, 1901.)

THIS work is not a treatise on the principles of sanitation, and, in fact, these principles are rarely referred to; it is rather a compendium of sanitary practice in the United States of America. The author devotes but little space to an expression of his own views, but his opinions whenever given are such as will meet with very general approval. In the introduction he states that the preparation of the present volume was primarily undertaken to meet his personal needs. An investigation along several lines of public health work suggested the utility of a comprehensive study of sanitary methods, and, as a consequence, this volume was prepared, in the hope that the material gathered together will prove as useful to other health officers as it has to the author.

The work is designed for American readers, but much of it will prove interesting and suggestive reading to those who have to do with sanitary administration in this country. The points which will perhaps strike the British reader most are: The extent to which the sanitary law or procedure may vary in different States; the scope and stringency of certain sanitary regulations; and the frequent paucity of efficient machinery to see that the law is observed. It is comparatively easy to frame an almost ideal set of sanitary statutes and regulations, but it is a very difficult matter to enforce them thoroughly, and it is evident that sanitary administration does not always keep pace with sanitary legislation in the United States. The average of all those cities of America, given in a rather long table on pp. 128 and 129 of the work, show the population for one inspector to be about 30,000; but in Providence there is only one to every 87,000 of population. A great many health officers, we are informed, receive no compensation at all, but serve their fellow-citizens simply from public spirit; thus in Minnesota in 1898, of 214 health officers, 83 received no pay, and one of these was in "a city of 5000 inhabitants." In villages, towns and cities of small or moderate size, the health officer is expected to do nearly all the sanitary work of the community. He acts as the secretary to the Board of Health, and attends personally to communicable disease, attaching placards, giving instructions and often doing the disinfection himself. He also investigates nuisances and often serves notices for abatement. As a general rule, the scale of pay to the health officers is very similar to that in Great Britain. It is, moreover, very generally the custom in cities, often of moderate size, for the health officer to be entrusted with the duty of collecting and recording the deaths in the population.

In America, boards of health, which are now established in all the States except Georgia, Idaho, Montana, Oregon and Wyoming, are given more or less legislative and executive authority in matters which experience has shown they can best control, but as a rule the State Board of Health is considered chiefly as an advisory board. In many cases the State reserves to its State Board of Health executive powers in matters of quarantine, the control of communicable disease and diseases of animals, the adulteration of food, &c.; and the State Board of Health in Massachusetts has, in addition, set an example in the work of investigation which it will be difficult for others to equal, and that Board's extensive experiments upon water and sewage purification are highly valued by sanitarians in this country. The principles of local self-government in sanitary as in other affairs is in the main recognised and adhered to. Outside of municipalities the sanitary organisation, usually in the form of boards of health, may be established either in townships or counties. Of the thirty-six States, twenty have provided for a county form of sanitary government, and sixteen have a township form of sanitary government.

Reference may here be made to a few matters of public health administration in the United States which are of special interest to British readers. The use of preservative in milk or cream is altogether forbidden in some States, and several State and municipal standards for milk require 3·5 per cent. of fat and 9 per cent. of solids non-fat—a higher standard than that which obtains in this country; and in the city of New York, condensed milk must contain fat to the amount of 25 per cent. of the milk solids. A few States (New York, &c.) require the application of the tuberculin test to cows kept in the city, and many States now attempt to secure the destruction of herds most affected with tubercle and to help farmers to free their herds from tuberculous animals. How much they have really accomplished in this direction is not entirely clear, but it does not appear to be great. Considerable opposition is experienced, and little is done save on the application of the owners themselves.

In most communities a placard or sign is put upon the infected premises to notify the public of the presence of infectious disease. Laws requiring the vaccination of school children have been declared constitutional in Indiana, Pennsylvania, New York and California; sometimes it is the teacher who is required by the statute to enforce the law, by excluding the unvaccinated; more often, however, it is the school board or school committee who are supposed to have full control of the teachers. Garbage (animal and vegetable matters from dwellings, shops, markets, &c.) is rarely removed less often than once a week, but in Washington it is removed *seven* times a week; in New York, Philadelphia and some other towns, *six* times; and six times weekly in the summer months of the year in many other instances. The dry refuse (ashes and rubbish) is not usually quite so frequently removed; the work is done in New York and Brooklyn *six* times a week, and in many cities two or three times a week, but in most communities the interval between removals is one week.

There is little doubt that more than one-half of the water furnished in the United States is wasted, for the *per capita* consumption in American is twice as great as that in European cities, and in the few American cities which are metered the *per capita* consumption is not one-half what it is in the unmetered cities. It appears to be the experience in America that meters diminish waste, but do not

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limit the legitimate use of water. In many States and cities either the ice is inspected or the source from which it is obtained, or the local sanitary authority controls its cutting or sale.

Spitting on the floor of public conveyances or on the side-walks—a dirty habit which creates a nuisance and favours the spread of tuberculosis—is prohibited by regulations which have been very generally adopted. It has, however, been found insufficient to forbid spitting on the floor of conveyances, as it is said that persons seeing such a rule have deliberately spat upon some other portion of the conveyance. A recent State definition of a nuisance (Utah, 1899) is very commendable. A nuisance is "whatever is dangerous to human life or health, and whatever renders soil, air or water impure and unwholesome." The Board of Health of Boston adopted regulations in 1900 for control of the barbers' trade; *inter alia*, mugs, shaving brushes and razors must be immersed in boiling water after every separate use thereof; alum, &c., used to stop the flow of blood, must be so used only in powder form and applied on a towel; the use of powder-puffs and sponges is prohibited; and every barber must cleanse his hands thoroughly immediately after serving each customer. These refinements of sanitation must be very difficult to enforce.

There are excellent reasons why the care of the sick poor should be a part of health department work, and the care of these is in a number of States wholly or partially in the charge of the health department. In most cases it is the outdoor or dispensary work which is given to the health department, but in rarer instances that department also manages the public general hospitals.

The sweating system is said to be associated with, if it be not the direct cause of, the most terrible phase of human life that is to be found in the United States. The "sweat-shop" is a manufactory in the dwellings of the very poor, among whom, if the home be healthy, the labour reasonable and the wages fair, such work is by no means to be discouraged; but the conditions of labour are often such as lead to the destruction of the home by the overcrowding and intense application and competition and the starvation wages of the sweating system. American legislation fails, like our own, to bring about any sufficient amelioration of the disease and misery entailed by the sweating system.

In conclusion, reference may be made to a very useful and full appendix of handbills, forms, notices, &c., used by different sanitary authorities in the United States, which adds much to the value of an interesting and important work.

THE CORRESPONDENCE OF HUYGENS.

Oeuvres complètes de Christiaan Huygens. Publiées par la Société Hollandaise des Sciences. Tome neuvième, Correspondance 1685–1690. Pp. 663 + 3 plates. (La Haye: M. Nijhoff, 1901.)

THE monumental edition of Huygens' works has now reached its ninth volume, and at least one more will be required to complete his voluminous correspondence. When reviewing previous volumes we remarked that many private letters of a non-scientific nature might well have been omitted, as their insertion is the principal cause of the great extent to which the work has grown; but this complaint does not apply to the volume now before us, in which there are scarcely any letters which one could wish omitted, as the few which do not treat of scientific matters give interesting glimpses of life and manners.

In the beginning of 1685 Huygens was still negotiating with the French Government about his return to Paris, and it is not quite clear whether he wanted to go back or not, and whether the revocation of the edict of Nantes was really the sole obstacle. Anyhow, nothing came of the correspondence, and he stayed on at The Hague till the spring of 1688, when he settled at Hofwijck, a property in the neighbourhood of the city which had belonged to his father (who died in March 1687) and of which his elder brother, Constantyn, lent him the use. As Constantyn was secretary to the Prince of Orange, his time was naturally much taken up with affairs of State, but he still found time to correspond with his brother on his favourite pursuit of telescope making, until he had to accompany William III. on his memorable expedition to England in 1688. Several letters give vivid pictures of the great anxiety felt in Holland after the departure of the fleet and the surprise and joy at the rapid progress of the Prince from Torbay to London. The interesting news contained in the letters of Constantyn from London inspired Huygens in the summer of 1689 with a wish to renew old acquaintances and make new ones in England, and accordingly he spent more than two months there, associating with Boyle, Halley, Newton (whom he now met for the first time), his old correspondent Duillier and others. The greatest scientific event of the time was, of course, the publication of Newton's "Principia" two years before. In June 1687 Duillier wrote to Huygens from London that some of the Fellows of the Royal Society were much excited over the approaching publication of a new work by Newton, and mentioned shortly some of the subjects dealt with in it. In reply, Huygens wrote that he was longing to see the book and did not object to the author not being a Cartesian, provided he did not make such an assumption as that of universal attraction. No doubt he and Newton must have had some conversations on the subject in 1689, and two memoranda by Newton on motion in a resisting medium probably date from this visit of Huygens to London. They were already published in 1701 together with a few notes written by Huygens in his copy of the "Principia," which after his death was acquired by a certain Groening, who imagined that Newton's memoranda (which are in his own handwriting) were also written by Huygens. In the "Discours de la Cause de la Pesanteur," published in 1690 with the "Traité de la Lumière," Huygens proves the earth to be an oblate spheroid and explains why the seconds' pendulum is of different length in different latitudes. But he assumes that gravity has its seat at the centre of the earth only, and in the appendix (written after the publication of the "Principia") he refuses to admit that all the particles of two or several bodies attract or tend to approach each other, as it seems clear to him that such attraction cannot be explained by any principle of mechanics. And in a letter to Leibnitz in

the same year he says that he often wonders how Newton could take the trouble to make so many researches and difficult calculations which have no foundation but this principle of universal attraction, which seems to him an absurd one.

With Leibnitz, Huygens was in fairly constant correspondence during the year 1690, chiefly on the subject of the differential and integral calculus, to which Leibnitz invited his attention; these letters have already been published more than once, but are here illustrated by several extracts from the notebooks of Huygens. After the publication of the "Traité de la Lumière" in 1690 (written in Paris twelve years earlier), Leibnitz wrote to express his surprise at, and satisfaction with, the undulatory theory, adding that when he saw how well it accounted for double refraction he passed from esteem to admiration. Papin also wrote to express his general approval, but otherwise there are very few allusions in the correspondence to the wonderful theory of Huygens, which had to lie dormant for more than a century before it even began to be seriously examined and to gain adherents. It is very curious that Newton should reject the undulatory theory of light while Huygens refused to accept the theory of universal gravitation, on both of which theories our modern natural philosophy is founded. But while the objections of Huygens did not retard the progress of the theory of gravitation, Newton's rival theory of light is certainly responsible for the long neglect of the true theory set forth by his Dutch contemporary.

Among the subjects which throughout Huygens' life continued to occupy his mind the improvement of clocks held one of the foremost places, and he never ceased to hope that in this way the important problem of finding the longitude at sea might be solved. Already, in 1662, he had his clocks tried at sea on a voyage from The Hague to London, but the attempt was a complete failure. Although he had in the meantime made the important invention of spiral-spring balances, he felt that even with this essential improvement no watch was to be trusted on a long voyage owing to the great influence of changes of temperature on the rate, and he therefore determined to try his pendulum clocks again at sea. In 1685 he cruised in the Zuyder Zee with two clocks suspended from the ceiling of the cabin in gimbals, and though the sea was very rough one of the clocks kept going the whole time. Encouraged by this success and being assured that the motion of a large ship would be far less violent than that which one of the clocks had been able to withstand, he had the experiment repeated in the following year in a ship belonging to the Dutch East India Company on a voyage to the Cape, giving the captain very detailed instructions as to the management and rating of the clocks. On the return of the *Alcmaer* in 1687 he learned that the clocks had kept going, though not as regularly as he had hoped. Huygens sent a lengthy report to the Company, with a large chart (reproduced in this volume) showing the track of the ship, first as estimated by the pilots, then as calculated by means of the clocks (passing right across Ireland and far to the east of the first one), and finally the same "allowing for the centrifugal force of the earth." This last track agrees fairly well with that laid down by the pilots. The matter was not lost sight of in the following years, notwithstanding the many other occupations of Huygens, and at the end of the volume we find again a number of letters exchanged between him and Graaf, who had brought the *Alcmaer* home from the Cape and who was then about to try the experiment again in another ship. But a great many years were to pass before Harrison solved the problem in quite a different manner.

It is impossible to read this splendid edition of Huygens' correspondence without being struck with the great care bestowed by the editors on their work. Throughout the volumes every allusion to persons, to contemporary events or to scientific matters is explained and commented on in footnotes, often of considerable length, which form a most valuable adjunct to the work. At the head of each letter it is stated where the original is to be found, whether it has been previously printed, and what letter it is in reply to or which one contains the reply to it. Future historians of the science of the seventeenth century will, indeed, have cause to thank the Haarlem Society of Science and especially the editors to whom this national undertaking has been confided.

In addition to the chart already mentioned, the volume contains a plate with views and plans of Hofwijck, where Huygens spent the last seven years of his life, and as frontispiece a fine portrait of the elder Constantyn Huygens from a drawing by his great son.

J. L. E. D.

ELEMENTARY BOTANY.

A Laboratory Course in Plant Physiology. By William F. Ganong, Ph.D. Pp. vi + 147. (New York: Holt and Co., 1901.)

Methods in Plant Histology. By Charles J. Chamberlain, Ph.D. Pp. viii + 159. (Chicago: University Press, 1901.)

First Studies of Plant Life. By Geo. Francis Atkinson, Ph.B. Pp. xii + 266. (Boston, U.S.A.: Ginn and Co., 1901.) Price 2*s.* 6*d.*

DR. GANONG seems to us to express sound views on the teaching of science in general and of plant physiology in particular, and the remarks on pp. 9 and 10 of his introduction might well be taken to heart by teachers; the same observation applies to his section on "Teaching and Learning," and careful consideration of the rest of this interesting manual convinces us that the author has much of the spirit of the true teacher in him. In other words, he has a share of that genius which calls forth from his students the desire to do something more than merely gather the opinions and statements of others as to the meaning of all those movements, exchanges of matter, increases in size and alterations in volume, &c., which constitute life.

It seems to us that a student who conscientiously works through the subject of this book, in the manner inculcated by the text and imbued with the spirit of inquiry manifested by the author, must learn much that is worth learning, both on account of its value as knowledge of the ways of living plants and on account of its significance in philosophy.

The experiments are as a rule simple, to the point, and

adequately but not over described; while the results, instead of being merely set forth by the teacher, have to be looked for and thought about by the student himself.

Faults there are, and probably must be in such a book, and we could criticise somewhat severely the meagre plan of a physiological laboratory submitted on pp. 29-30, and the outline course of study of structure and of the properties of protoplasm; but against these deficiencies may fairly be set some neat suggestions and devices, as, for example, those on comparative polygons (p. 15) and for experiments on germination, root-pressure, geotropism, &c. We do not like such terms or expressions as "borrowable" (p. 58), "diagramming" (p. 75), "other tropisms" (p. 132), and quite fail to understand how it can be said (p. 135) of locomotion that it is "almost purely ecological, with but a slight basis in pure physiology."

Nor can we pass over the following without protest: "5. What is the chemical composition of living protoplasm?" (p. 52). It is obvious on reflection that we know nothing of the chemical composition of *living* protoplasm.

We are also struck with the untidy appearance of some of the experiments—*e.g.* Fig. 13—though not all.

The information (pp. 71-72) regarding nutritive solutions, and (p. 100) water cultures is too meagre; and to say of absorption (of lithium citrate) "But perhaps such absorption is too obvious to need special experiment" is a flagrant departure from the excellent principles inculcated elsewhere.

On the other hand, surely the following precaution with the clinostat is of the order of trivialities: "The clock will need winding once in two days, and while the cork is removed for the purpose, it should be kept slowly revolving in the hands" (p. 121).

A clearly written, excellently printed and compact little handbook for the beginner in laboratory practice has long been wanted, and Dr. Chamberlain's volume comes nearer to satisfying the want than many. But it has, in our opinion, one fundamental drawback which would spoil its claims to be—what it might have been—*the* elementary laboratory book of methods for botanists, namely, in attempting to be both a guide to laboratory methods and a handbook of exercises in plant-histology, each of its double functions being too incomplete in treatment. For instance, the meagre description of the paraffin bath on p. 4 should either be clearer or omitted altogether, and the practical value of the curious formulæ for alcohols on p. 9 seems to us not obvious. On the other hand, the recommendation to inoculate a mouse with *Anthrax* (p. 76) can hardly apply to an elementary student, and several of the studies—*e.g.* of *Xylaria* (p. 83), *Marsilea* (p. 111), &c.—seem to us both unsuitable and inadequate in treatment. The poor photographic figures of nuclei in *Lilium* are also unnecessary.

In spite of these criticisms the first half of the book contains many useful hints on methods, and we should like to see it expanded, to the ultimate exclusion of the second half.

Dr. Atkinson's little book has a wealth of excellent illustrations and some ideas of value to the teacher and student of purely elementary botany or "Nature study," but it only brings out once more the clear issue that all such teaching depends for its efficiency on the genius of the individual teacher. In the right hands, Chapters xv.-xvii., for instance, dealing with the formation of starch in the living plant, will assume delightful aspects. We do not doubt that this would be the case in the hands of the author, but even his simple style and ingenious illustrations show only the more clearly that all depends on the personality of the teacher in these fundamental matters. The section on "Battles of Plants in the World" is excellent reading, but we doubt if children could be made to appreciate the subject except in the open air and in the company of the ideal teacher, who is rarely or never present with the book.

TRUTH AND ERROR IN VON KÖLLIKER.

A. von Kölliker's Stellung zur Descendenzlehre. Ein Beitrag zur Geschichte moderner Naturphilosophie. Von Dr. Remigius Stölzle. Pp. 172. (Aschendorffsche Buchhandlung, Münster i. W., 1901). Price Mk. 2.

DR. REMIGIUS STÖLZLE, professor of philosophy in the University of Würzburg, has paid his illustrious scientific colleague A. von Kölliker a great compliment. He has dissected Kölliker's works, and separated the wheat from the chaff, as he did not long ago in the case of Karl Ernst von Baer. The analysis of nine important works, from an article on Darwinism in 1864 to the veteran's interesting "Erinnerungen" in 1899, is careful and scholarly, and the critical exposition is arranged so clearly that the reader can find out at once what Kölliker thought about variation, heredity, natural selection, or the like. While the author has very strong convictions, he expresses these with a dignified restraint, and says nothing harder against naturalists than that it is a pity to be too busy to take advantage of philosophical discipline. For those who are fond of argument the book will serve as an interesting introduction to the problems of organic evolution.

Prof. A. von Kölliker's contributions to biology—through more than half a century—have been many and varied; indeed, the magnitude of his work, alike in quantity and quality, is a lasting example to the spirit of research; and, though it is difficult always to read with patience, Stölzle's detection of "fundamental errors" is really part of a tribute to the anatomist's greatness. Is not criticism, after all, the sincerest form of flattery? But there is, by the way, a lack of discernment or of the sense of humour in placing Profs. Fleischmann and Weismann side by side among those who are responsible for recent "Angriffe oder Verdikte" on Darwinism.

The first great error is a purely mechanical interpretation of nature, the second is a denial of purposive principles, and the third is an evolution theory which is said to leave no *rôle* for the Creator. In evidence of these hateful heresies there is no lack of citation of chapter and verse; nor is it to be supposed that the author simply *calls* them "Irrgänge des Denkens"; he seeks to substantiate his accusations, and to those who agree with him the case will doubtless appear convincing.

But there is a brighter side to the picture; there is truth as well as error in the writings of Albrecht von Kölliker. Of permanent truth (von bleibender Wahrheit)

is his critique of Darwinism; it has stood the test of time and is now admitted as justified, "and Darwinism, for scientific circles at least, is at its last gasp. Weismann, the toughest champion of Darwinism, can now write over all his works devoted to the rescue of the selection-principle, '*In vanum laboravimus.*'" These are brave words, but the game is "bluff."

A second "permanent truth" expressed by von Kölliker was that organic evolution can only have come about through internal factors, for von Kölliker is one of the many who have groped after "an unknown factor," a "phyletische Lebenskraft." It has often seemed like a clue, this idea of an internal tendency to progress, but it has not as yet led us anywhere; and we relapse from obscure talk about "bathmism" into an ætiology like Topsy's "specks I growed." There may be some with the bad taste to prefer Weismann's "germinal selection."

A third "permanent truth" in von Kölliker's position is that "he regarded all theories of descent, including his own, as having only the status of probabilities," and this is to appraise them rightly. In other words, evolution-theories were to him, as to most clear-headed people, simply conceptual formulæ more or less justified by their success in fitting the facts. Here, at least, those who regard von Kölliker's heresies as expressive of a useful scientific method and those who denounce them as errors of judgment, those who stand by the selection-idea and those who think that it has been literally worked to death, may find a provisional peace, until they begin again to try if they cannot get "any forrarder."

J. A. T.

OUR BOOK SHELF.

A Treatise on Medical Jurisprudence. By G. V. Poore, M.D., F.R.C.P., Professor of the Principles and Practice of Medicine, University College, London. Pp. xxiv+533. Eighteen illustrations. (London: John Murray, 1901.)

THE book before us consists essentially of a series of lectures delivered by Dr. Poore at University College during the time when he occupied the chair of medical jurisprudence in that institution; now that he has passed to another sphere of duties, it is well that his labours as a teacher of this most important subject should endure in the concrete form of a manual. The lectures have been freely edited by himself, and doubtless touched up by others, but in spite of this they remain still essentially lectures, delivered in a pleasant colloquial style; if from the point of view of highly systematised contents, something by this method has been lost, something has also been gained, in that the volume before us may certainly be designated one of the most readable which it has ever fallen to our lot to peruse.

To turn from the manner of the book to its matter, it is quite impossible in a short notice to do adequate justice to the mass of fact which it contains. The book is not very fully indexed, and to get an adequate idea of its contents the table of contents itself must be read. This consists of a series of detailed chapter headings which are repeated throughout the book at each chapter.

Inter alia we would draw special attention to Chapter ii., which deals with the legal relations of the medical profession. The subject-matter of this chapter, as in many others throughout the book, is elucidated by illustrative cases culled from the records of the Law Courts. Amongst these cases we may mention the Tichborne, Palmer, Lamson and Maybrick cases, each of which is fully described under the subject which renders them of permanent interest to the medical jurist. With regard to the toxicological part of the subject, the author adopts the wise method of only dealing with the symptoms produced by, and the detection of, those poisons which have actually been used criminally. An interesting chapter on food-poisoning is, we venture to think, not strictly within the scope of the work. The criminal of to-day is perhaps turning his attention to ptomaines, and it may be that the criminal of the near future will actually employ them. It is only to be hoped that modern chemistry will be equal to the task of their identification. A very useful chapter for the medical practitioner is the one upon insanity, and the one immediately following, upon the legal relations of the insane. In these two chapters he will find full information with regard to what is very often a puzzling subject, viz. what to do and how to do it when one is suddenly called to a case which obviously requires restraint. Is it to be wondered at that the busy medical man has sometimes to be censured for not complying with the law when, as Dr. Poore tersely puts it, the law in question contains more than three hundred sections and clauses, and weighs half a pound?

The volume concludes with eleven appendices upon various subjects of importance to medical jurists. Amongst these may be mentioned a most interesting appendix (illustrated) by Dr. J. G. Garson upon "The metric and finger-print identification of criminals as carried out at New Scotland Yard."

We may close our remarks by saying that Dr. Poore's book deserves, and will surely have, a very wide circulation, supplementing rather than replacing the more systematised and voluminous works upon this subject.

F. W. T.

Ueber Museen des Ostens der Vereinigten Staaten von Amerika; Reisestudien. By A. B. Meyer. Part ii. Illustrated. (Berlin, 1901.)

IN this fasciculus the learned Director of the Royal Zoological and Ethnographical Museum of Dresden concludes his interesting account of the museums and libraries of the United States visited during his recent tour. Here we may avail ourselves of the opportunity of correcting a misrepresentation of the author's opinions which unfortunately occurs in our notice of the first portion of his work. Instead of stating that Americans are ahead of us in the matter of museum fittings, Dr. Meyer awards the preeminence in this respect to European institutions, although he is fain to confess that as regards libraries and library installations we are not abreast of America.

In the present part Dr. Meyer discusses the chief public institutions of Chicago connected with art, literature and science, namely, the Field Columbian Museum, the Academy of Sciences, the Historical Society, the Art Institute, the John Crerar, the Newberry, and the Chicago Public Libraries and the University. The Field Columbian Museum, which was opened in August 1893, during the Chicago International Exhibition, under the title of the Columbian Museum of Chicago, owes its existence to private liberality, and in May 1894 was renamed in honour of its founder, Mr. M. Field, of the firm of Marshall Field and Co. On Saturdays and Sundays the Museum is open free to the public, but on other days a small admission fee is charged, although the scholars attending elementary and secondary schools are always admitted without charge. Dr. Meyer furnishes his readers with a plan of the ground floor and another of the galleries, and discusses the general arrangement of the rich collections and the mode of cataloguing. At the conclusion of his article he expresses himself dissatisfied with the building, which he considers inadequate to the contents, urging that if this were remodelled the Museum ought to take rank among the first in the world.

Of the other institutions named, Dr. Meyer considers that the small museum of the Academy of Sciences is a model of its kind; and that the Art Museum is in many respects remarkable, and, like the other institutions, worthy the best attention of all interested in such matters. The Newberry and John Crerar Libraries, which are for reference only, display many features of their own, and will in the near future be of the highest importance as the scientific libraries of the Central United States. The Chicago Public Library, on the other hand, is a circulating one, which lends out, according to the author, millions more volumes than any other institution in the world; it is, in fact, a unique institution. As to the University, which is described in considerable detail, Dr. Meyer has no doubt that it is assured of a great future, the progress it has made and the influence it exerts, after an existence of only a decade, being little less than marvellous.

To all practically interested in museum and library work and progress, Dr. Meyer's observations and criticisms should be invaluable. R. L.

The Mechanical Triumphs of the Ancient Egyptians. By Commander F. M. Barber, U.S. Navy. Pp. x + 123. (London: Kegan Paul and Co., Ltd., 1900.) Price 3s. 6d.

THE writer is a well-read sailor, who has devoted much time to answering as plausibly as possible the common query of travellers, "How did the Egyptians transport such great stones from their quarries as the stones for the pyramids, the colossi and obelisks, and lift them to their present positions?"

He discusses the Egyptian knowledge of the mechanical powers, the capstan and windlass known in the first three dynasties, the single pulley B C. 3500, the inclined plane very early, the screw and the Spanish windlass also early.

He thinks that the heavy stones of the lower parts of the pyramids were brought on rafts by water, then up long inclined planes of gentle slope to their actual positions. The lighter stones of the upper parts may have been lifted, possibly also the casing stones, by levers, but he finds reason to believe that the screw-jack was in common use for this and other purposes. He describes the quarrying, the carrying and polishing of very hard stones with such tools as the Egyptians possessed; he is much at home in his discussion of the shapes and strength of boats used for conveying two obelisks at a time and how they were towed, and he compares the modern methods of lifting obelisks into position with his plausible account of how the ancients performed such operations.

Cours de Mathématiques à l'Usage des Élèves-Architectes et Ingénieurs Professé à l'École des Beaux-Arts. Par Carlo Bourlet. Pp. iii+244. (Paris: C. Naud, 1902.) Price fr. 8.

THIS is an elementary treatise on what is often called higher mathematics, the parts of which are taken up in the following order:—Differential calculus; analytical geometry of two dimensions with calculus applications; integral calculus; three-dimensional geometry. It seems to be made up of the most elementary parts of three or four treatises, but there is nothing new in the treatment. One might have expected the author to illustrate the well-known rules of differentiation by showing how applicable they are to the problems of the builder and engineer, to have greatly shortened the proofs and lessened the number of rules for differentiation, and so forth; but we here find practically nothing of the kind. The conic sections are still the important curves; the student gets rules enough for the most elaborate differentiation and integration and, in fact, enters in the most orthodox way upon a course of pure mathematics; but this book is in no way written to satisfy the special needs of the architect or engineer. But the author is to be praised for teaching the calculus, in however dry a manner, before coordinate geometry. We wish he had used the calculus to help in teaching coordinate geometry, but he only makes a combination after he has taught both subjects.

Physical Determinations. By W. R. Kelsey, B.Sc., A.I.E.E. Pp. xii + 316. (London: Edward Arnold, no date.) Price 4s. 6d.

THIS book contains, in a space of 310 pages, 185 sections each of which deals with generally one and sometimes more experiments. The subject-matter spreads over the whole range of physics. It is consequently packed tightly; and so the author has had to omit details, but he has endeavoured to give sufficient information to enable a class to start work without waiting for individual instruction from the demonstrator. It is claimed that the book contains most of the exercises which have been set at the London Intermediate and B.Sc. examinations.

The exercises are of very variable degree of difficulty and are not graded, so that a teacher adopting this book for elementary classes will have to make a careful selection. One use of the book will be to look up the whole subject the night before an examination.

S. S.

Proceedings of the Aristotelian Society. New Series. Vol. i. Pp. 239. (London: Williams and Norgate, 1901.)

THE existence of the Aristotelian Society illustrates one of the best features of English philosophical study, its freedom from the tendency, often so strongly marked in continental countries, to organise itself into little schools, each with some master, whose decisions are unquestionable, and his band of unquestioning disciples. The present volume, like its predecessors, is pleasingly marked by the tone of free inquiry and unprejudiced discussion natural to a society in which adherents of the most various philosophical principles attempt to make themselves reciprocally intelligible. The contents of the book include contributions to most departments of philosophy, except that there is no paper dealing directly with ethics. Among the essays concerned with metaphysics the most important are the three in which Dr. Shadworth Hodgson, the Nestor of the society, defends his well-known views on causation, substance, and the nature of the conscious subject of psychology, and the discussion of identity by Mr. G. E. Moore. Of the papers on other subjects perhaps the most attractive is Mr. Sturt's on "Art and Personality." Mr. Beneke's discussion of the "Aspect Theory of the Relation of Mind to Body" is suggestive, though impaired by the writer's voluntary abstention from metaphysical thoroughness. A. E. T.

The Play of Man. By Karl Groos. Translated by Elizabeth L. Baldwin. Pp. ix + 412. (London: Heinemann, 1901.)

PROF. GROOS'S work, "Der Spiel des Menschen," has already been noticed in this column, in connection with the appearance of the German original. It is therefore superfluous to say more than that the work, both for wealth of information, soundness of judgment and charm of literary style, is in every way worthy of its earlier companion study of "The Play of Animals." Apart from its purely psychological interest, the book has a serious value for the pedagogue who desires to form his own judgment as to the educational effects of games and the uses and dangers of the play-impulse. It is to be hoped that so good a book will have in its English dress the deserved success already attained in this country and America by "The Play of Animals." The translator has done her work well, and Prof. Baldwin contributes a preface and a few footnotes.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

The Red (C) Line of Hydrogen and the Zeeman Effect.

FOR some months we have been engaged in an investigation of the effect of a magnetic field on the more conspicuous lines of certain elementary gases, including the case of helium referred to by Prof. Gray and Dr. Stewart in your issue of November 21. We have employed a very fine echelon grating of twenty-six plates by Hilger. One observation that we have already made is, perhaps, of sufficient interest to deserve mention in your columns. The red (C) line of hydrogen was unmistakably divided before the application of the magnetic field. A reference to Michelson's papers on the application of interference methods to spectroscopic measurements showed that he had announced the red hydrogen line to be a very close double as long ago as 1887. A more detailed examination of the visibility curve is given in the *Philosophical Magazine* for September, 1892, from which it appears that the curve is practically the same as that due to a double source, whose components have the intensity ratio 7 : 10, and in each of which the light is distributed according to the exponential law resulting from Maxwell's theory of velocities. The distance between the components is given as $1\cdot4\times10^{-3}$ millim., so that it should be well within the power of the echelon as at present constructed to resolve the line.

Under the influence of the magnetic field each component is widened, and by using a double-image prism as recommended by the late Prof. Preston to separate the constituents, is seen to give rise to the normal triplet.

It is necessary for these observations to use a vacuum tube giving a bright crimson light in the capillary portion, and it is an advantage to have the tube in connection with the pump and a supply of hydrogen while under observation.

We hope to be able to publish quantitative results regarding this and other lines when our researches are further advanced.

BLYTHSWOOD,
H. S. ALLEN.

Blythswood Laboratory, Renfrew, N.B., November 25.

On the Probability that the Son of a very highly-gifted Father will be no less Gifted.

AN abstract was presented last Thursday to the Royal Society by Prof. Karl Pearson of results that apparently showed in a most conclusive way "that the mental characters in man are inherited in precisely the same manner as the physical." His data and work have yet to be communicated, but the figures, which were given separately, for four physical characters in from 800 to 1000 pairs of brothers, and for seven mental characters in another equally large set, are closely the same in all eleven instances, and they seem to substantiate his conclusion up to the hilt.

As the question of inherited ability may thus be brought again to the front, perhaps you will allow me space to refute a specious objection which is likely to be adduced, as it has already been urged with wearisome iteration, namely, that the sons of those intellectual giants whom history records, have rarely equalled or surpassed their fathers. In reply, I will confine myself to a single consideration and, ignoring what Lombroso and his school might urge in explanation, will now show what would be expected if these great men were as fertile and as healthy as the rest of mankind.

The objectors fail to appreciate the magnitude of the drop in the scale of intelligence, from the position occupied by the highly exceptional father down to the level of his *genetic* focus (as I have called it), that is to the point from which his offspring deviate, some upwards, some downwards. They do not seem to understand that only those sons whose upward deviation exceeds the downward drop can attain to or surpass the paternal level of intelligence, and how rare those wide deviations must be.

The exceptional quality of the father is only one of four elements that contribute in apparently equal shares to determine the position of the genetic focus. The other three are (1) the quality of the mother, (2) that of the paternal ancestry, (3) that of the maternal ancestry. In the case we are supposing the mother may occupy a high, though almost necessarily a lower, position on the scale of intelligence than the father. Where, for instance, could an intellectual giant like Napoleon find an equal mate? The average ancestry, whether of the father or of the mother, are always more or less mediocre, some ancestors being above and others below the general level of intelligence. Consequently the exceptional quality of the father, considered apart from his ancestry, is not likely to raise the position of the joint genetic focus of himself and the mother by more than a quarter of its amount. Let us consider the far from overstrained case of a father whose intelligence exceeds mediocrity by an amount that lies between seven and eight times that of the "probable error" of the distribution of racial intelligence. Extending the nomenclature employed in my lecture, which you published on October 31, his class would be Y. I will suppose his wife to be a woman of such ability that her equal is only to be found once in every fifty persons, that is of class U. Then the class of the mid-parent would be half-way between Y and U, or W. Regression which is due to the joint ancestral influences would degrade W by at least two classes, that is from W to U, which makes a total drop of four classes from the Y from which we started. Only those children who deviate upwards to that large extent can equal their father. But the conditions are still harder than they appear, because of the closeness with which the sons are clustered round the common filial (or genetic) centre. Their modulus of deviation is less than that of racial deviation, so that it would need fully five steps of filial deviation to reach the required level, and hardly one in 300 deviates do that. He might have many sons more or less distinguished, sons classifiable as W, X, or V, as experience shows to be the case, but the probability of a Y father having a Y son is remote. All the same, a Y father is more likely than any one man of a lower class than his own to have such offspring, but as the latter are very numerous the supply of Y men comes chiefly from them.

I have looked again at my "Hereditary Genius," written many years ago, under the light of newer knowledge, and feel that the evidence there recorded of the inheritance of ability is quite as strong as theory would lead us to expect.

I must not trespass further on your space, though the subject tempts one to go far into details. FRANCIS GALTON.

Pigments of Nudibranchiate Mollusca.

LAST summer, on the coast of California, I had occasion to study three species of the beautiful genus Chromodoris, all of them hitherto undescribed. Technical descriptions have been sent for publication elsewhere, but the purpose of the present note is to call attention to the interesting pigments possessed by these animals. *C. universitatis* (so called because it bears the colours of the University of California) is a large species, more than 2½ inches in length, of a rich dark ultramarine blue, the edges of the mantle and foot bright cobalt blue. The mantle has two longitudinal series of oblong very bright orange spots, about seven in a series; there are also five orange spots on the anterior part of the mantle. The sides of the foot also exhibit a row of orange spots.

When the animal is placed in formalin (4 per cent.) it immediately gives into solution a strong blue colour. This colour is even dissolved out, though more slowly, by sea water after the death of the animal. The blue solution is bleached by caustic potash, and is immediately turned pink (about the colour of apricot flowers) by hydrochloric acid.

The orange spots are not affected by formalin, but, curiously, when seen through the blue solution, they appear bright red. *C. porterae* (from La Jolla) is a small species, about 11 mm. long, blue as in the first species, with two rather broad longitudinal stripes of bright orange on the mantle. There is an inconspicuous median line of a lighter blue. After death the blue (evidently the same pigment as that of *C. universitatis*) dissolves out, and the body becomes a sort of pale greenish, with the dorsal stripe on the mantle very white. The orange bands are not affected.

The third species, *C. mcfarlandi* (from La Jolla and San Pedro), is about 35 mm. long, the mantle brilliant purple with a yellow margin and three longitudinal yellow stripes. The end

of the foot is purple, with a longitudinal orange stripe. The orange pigment is evidently the same as that of the other species, but the purple is different from the blue and does not dissolve out in formalin.

No doubt all these pigments represent "warning coloration."

T. D. A. COCKERELL.

East Las Vegas, N.M., U.S.A., November 10.

The Ash Constituents of Some Lakeland Leaves.

A FURTHER series of experiments bearing on the question indicated in this journal (vol. lxiii., No. 1634, p. 396) was undertaken during the summer and autumn of this year. It was deemed advisable to extend the research over a pretty wide range of subjects, so as to be able, if possible, to catch some kind of clue towards the correct elucidation of the causes operative in the case. The capital object in view was to ascertain the exact amount of inorganic constituents (especially silica and lime) which the leaves extract from the soil at different periods of their life, so as to determine whether this particular amount has any connection with the chemical composition, &c., of that particular soil. In all cases the entire leaf and petiole were used dried at 100° and then incinerated, the same vessel and the same source of heat being used for each separate incineration.

Leaves of	Date.	Percentage of crude ash.	Percentage of silica (SiO_2) and of lime (CaO) in the crude ash.	
			SiO_2	CaO
Beech	May 17	4·8		
,, ...	July 30	5	17	27·4
,, (brown)	Nov. 3	6·8	27·2	23·7
Oak	Aug. 17	5·8	12·2	29
,, (brown)	Nov. 3	6·8	14·5	37·5
Hazel	June 10	3·3		
,, ...	Aug. 4	5·7	6·2	26·8
,, (orange)	Oct. 27	6·3	15	28·6
Alder	July 29	4·9	1·8	31
,, (falling)	Nov. 1	5·7	1·7	33·6
Linden	May 30	5·5		
,, (yellow and brown)	Oct. 18	10·8	2·5	34·8
Ash	June 12	7·7		
,, ...	Aug. 2	6·7	1·5	37·7
,, (yellow)	Oct. 27	9·5	5·3	34·3
Elder	May 21	8·7		
,, (yellow)	Oct. 24	8·5	9·5	31·5
Scots pine (old leaves)	Aug. 19	2·5	9·4	15·9

On reviewing the foregoing table there would seem at first sight to be nothing remarkable therein; but a little collation and comparison serve to throw a more searching light upon the subject. All these trees and shrubs have sprung from a siliceous gravelly soil charged with basic constituents, but rather poor in lime (well under 12 per cent.). Nevertheless, the leaves of ash, alder and oak have managed to secure an amount of lime which may be regarded as nearly, if not quite, their full complement of that substance. The high proportion of lime in alder leaves may be referred to the very low proportion of silica; but this is hardly feasible in the case of the ash and oak. The ash-leaf, with a feeble proportion of silica, maintains a considerable quantity of potass and an amount of lime necessary to neutralise the organic acids which it produces in very notable degree. The oak-leaf, with far less potass in autumn, demands for the annulment of its organic acids (chiefly oxalic) a supply of lime apparently commensurate with its unique faculty for the production of starch. It will be specially observed that while, as indicated by the similar ratio of ash, the leaves of beech and oak have reached on November 3 a coequal measure of decay, that of the beech is evidently farther fallen. The leaves were selected for the experiment from beech trees flourishing right vigorously on the sandy shelving banks of the bays which indent the upper reach of Ullswater. The result was so remarkable that the experiment was repeated with every care and precaution, but the amount of silica remained as imperturbably high as before. The tree is a decisive alien in Lakeland and its seeds never ripen here, but in a sheltered situation on a sandy bottom it presents an aspect of unquestionable health and sturdy adaptation to the circumstances.

P. Q. KEEGAN.

Patterdale, Westmorland.

Note on a Point of Chemical Nomenclature.

THE use made by Mr. Goodwin and myself, in a recent communication to the Chemical Society, of the term *alphyl* is the occasion of an interesting letter from "A. T. de M.," published in NATURE (October 31, p. 648). The history of the term *alphyl* and its replacement by Prof. Vorländer's term *arryl*, or, better, *aryl*, the form in which it has been generally adopted, is correctly stated. In the interest of so important a matter as uniformity in chemical nomenclature I willingly agree with "A. T. de M.," and will adopt *aryl* instead of *alphyl* for monovalent aromatic hydrocarbon radicals (C_6H_5, $C_6H_4CH_3$, &c.).

But Prof. Vorländer goes further than this, and his view is advocated by "A. T. de M." He proposes to alter the well-understood meaning of the term *alkyl*, to retain the term *alphyl* with a new meaning and to introduce the combination *alpharyl*. These proposals seem to me not only confusing, but unnecessary. Let us retain *alkyl* in its old meaning, adopt *aryl* for monovalent aromatic hydrocarbon radicals and use *acyl* for all monovalent acid radicals. The terms *alkylene*, *arylene* and *acylene* might be adopted for the corresponding divalent radicals without introducing a new termination. For the radical benzyl and its homologues, if it be thought desirable, *ar-alkyl* could be employed.

ALFRED SENIER.

Queen's College, Galway, November 17.

Does Man use his Arms in Locomotion?

IN "Monkeys; Their Affinities and Distribution," by Dr. A. R. Wallace (reprinted in his "Studies; Scientific and Social," vol. i.), the author gives (p. 183) as one of the characters in which man *differs* from all the monkey tribe—"*the perfect freedom of the hands from all part in locomotion.*"

My object in writing is to point out the peculiar way in which the majority of people move their arms and hands when walking or running. One may safely say that everybody, adults and children, at one time or another exercise this movement. The natural way in which children run is to "paddle" with the arms and hands, though trained runners do not do so.

Now is it not possible that this muscular movement of the fore-limbs in opposite directions in the act of locomotion is a survival of the four-legged mode of progression of man's remote ancestors? The anthropoid apes, we know, get about by the aid of their arms and hands; while the baboons walk much in the same way as dogs do. The examples and illustrations could be enlarged upon indefinitely, and it is not for me to do so. I believe that this theory has been thought of before, but I am unable to find any trace of it in the books I have consulted. I should be very grateful if any of your readers would enlighten me on the subject.

BASIL W. MARTIN.

Elm House, Hampstead.

CELEBRATION OF THE JUBILEE OF M. BERTHELOT.

THE Berthelot jubilee, celebrating the fiftieth anniversary of the publication of Marcellin Berthelot's first scientific work, was held in the Great Hall of the Sorbonne, in the University of Paris, on Sunday, November 24. The President of the Republic, M. Loubet, was in the chair, surrounded by the Ministers of the Cabinet, the Ambassadors of the various countries in the French capital, and numerous delegates from foreign and from local scientific societies.

The hall, a large amphitheatre, capable of seating more than 3000 persons, was packed with those who delighted to do honour to M. Berthelot. Behind the daïs, in the

front of which the President was seated, is a large fresco representing Arts and Science; and round the amphitheatre there are niches containing busts of Robert de Sorbon, the founder of the Sorbonne, or University of Paris; of Richelieu, Pascal, Descartes, Lavoisier and Rollin—the *élite* of the Frenchmen who have exercised influence on French education and on arts and sciences. On the right of the President the band of the Garde Républicaine welcomed him with the Marseillaise, the audience all standing, and the proceedings began punctually at 10 a.m. They were opened by a discourse from the Ministre de l'Instruction publique, M. Leygues, who gave an impassioned address on the services which M. Berthelot had rendered to French education; he noted how the ubiquity of M. Berthelot's genius had led him to pay attention, not merely to scientific work, but also to extend his purview to the systems pursued in schools and to the primary and secondary education of French citizens. M. Darboux, sécretaire perpetuel of the Academy of Sciences, in a careful and well-delivered address, alluded specially to M. Berthelot's contributions to general science and to the recognition of his labours, testified by the international response to requests for subscriptions, and to the numerous societies and associations which had presented him with addresses. M. Darboux was succeeded by M. Fouqué, president of the Academy of Sciences, who echoed what M. Darboux had said and expressed the gratification of the Academy that one of its members, who had devoted his life to the pursuit of truth for its own sake, had, in receiving respect and recognition from the whole civilised world, conferred honour on the body of which he had so long been a member, and whose proceedings he had enriched by so many valuable contributions.

M. Moissan, now professor of chemistry at the Sorbonne, gave in his address an account in general terms of M. Berthelot's contributions to chemical science. As early as 1855 Berthelot's work on sugar, which led to the synthesis of formic acid and of alcohol, directed the attention of chemists, who had formerly regarded analysis as the chief aim and end of chemical work, to synthesis. Although the idea of a "vital force" had been attacked by Wöhler and Liebig, still Berthelot, by numerous brilliant syntheses, contributed more than anyone, during the decade 1855–65, to render the idea untenable. In this he was helped by his friends Pasteur and Claude Bernard, each of whom, at the later date, was laying the foundations of the work which rendered his name immortal. M. Moissan aptly remarked, in alluding to "vital force," "nous avons d'autant plus de théories que la chose est moins claire." Sketching rapidly Berthelot's work on acetylene, on explosives, on thermochemistry, on the absorption of nitrogen by plants, and his contributions to chemical history, he having translated and edited numerous Greek and Arabic writers on the subject, he concluded by the remark that, owing to the universality of his knowledge and attainments, M. Berthelot must be regarded as the last of the "encyclopædists." The address was concluded by the phrase, "Nous vous remercions pour nous avoir donné un peu plus de la verité."

M. Gaston Paris, one of the executive of the Collège de France, was the next speaker. He alluded to the long connection which had subsisted between M. Berthelot and the Collège de France. In 1851 he was recommended by Balard as deserving of the position of his "préparateur," or assistant. After eight years, however, he migrated to the École de Pharmacie, where, in 1865, he was made "Professeur titulé" of organic chemistry. Shortly after, however, he was recalled to his old home, the Collège de France, where he has remained ever since, in spite of numerous calls to accept more lucrative positions elsewhere.

After a few words from the president of the Academy of Medicine, Emil Fischer, the eminent professor of chemistry of Berlin, read an address in German from the Prussian Academy of Sciences, and at the same time presented one from the German Chemical Society; Dr. J. H. Gladstone followed, introducing first Prof. Ramsay, who, after a few prefatory remarks, read the address sent by the Royal Society, and next Prof. Emerson Reynolds, who presented an address from the Chemical Society, of which he is president; and lastly Dr. Gladstone handed in an address from the Royal Institution. Prof. Lieben, of Vienna, conveyed the congratulations of the Imperial Academy of Vienna; and Prof. Guareschi, those from the Academy of Turin. M. Troost, the former professor at the Sorbonne, read a list of academies and societies which had sent congratulatory addresses, so numerous that nearly a quarter of an hour was occupied by the mere recitation of the names; and concluded by reading a personal telegram from the King of the Belgians, conveying His Majesty's felicitations, and announcing that the Queen Regent of Spain had conferred on M. Berthelot the Grand Cordon of the Order of Charles III.

The following translation of M. Berthelot's speech in acknowledgment of the tribute to his genius and scientific work is from Monday's *Times*:—

I am deeply touched and really embarrassed by the homage which you are offering me to-day. These honours, I am aware, are not due merely to your affection for my person, I must attribute them also to my age, my long labours, and to certain services which I have been able to render to our Fatherland and to my fellow men. Your sympathy makes the lamp which is about to be extinguished in the everlasting night shine with a final brilliancy. The respect of humanity for old men is the expression of the solidarity uniting present generations with those that have preceded us and with those that are to follow. What we are, in fact, is only to a very slight degree attributable to our personal labour and individuality. We owe it almost entirely to our ancestors, ancestors by blood and our spiritual ancestors. If each of us adds something to the common domain in the field of science, of art, of morality, it is because a long series of generations have lived, worked, thought and suffered before us. It is the patient labours of our predecessors who created the science that you are honouring to-day. Each of us, whatever his individual initiative, must also attribute a considerable portion of his success to contemporary *savants* concurring with him in the great common task. In fact, no one—let us proclaim it loudly—no one has the right to lay exclusive claim to any of the brilliant discoveries of the past century. Science is essentially a collective work, prosecuted during the course of time by the efforts of a multitude of workers of all ages and every nation succeeding one another and associated by a tacit understanding for the search of pure truth, and for the application of this truth to the continuous transformation of the condition of all men.

Of yore *savants* were looked upon as a little group of amateurs and men of leisure maintained at the charge of the working classes, and executing a task of luxury and pure curiosity for the amusement and distraction of those favoured by fortune. This narrow and unjust view which paid so little heed to our devotion to the truth and our services, this prejudice, finally disappeared when the development of science showed that the laws of nature were applicable to the practice of industries, and had as a consequence the substitution for the old traditional and empirical receipts of the profitable rules of the theories based on observation and experience. To-day who would venture to regard science as a sterile amusement in presence of the general increase of national and private wealth which results therefrom? To confine ourselves to mentioning the most interesting perhaps of the services which science has rendered, it suffices to compare the servile and miserable condition of the popular classes in the past as revealed to us by historical documents with their condition at present, already so advanced in dignity and well-being without counting the just hopes of which they are pursuing the realisation. Is there a statesman who doubts the services, greater still, which are to be looked for as the result of this incessant progress? Science

is the benefactor of mankind. Thus it is that the tangible utility of scientific results has convinced the State that laboratory work should be encouraged and sustained, because it is economically a benefit to all, and for the public health. Science carries still further its legitimate pretensions. It claims to-day at once the material direction, the intellectual direction, and the moral direction of human society. Under its impulse modern civilisation marches with a more and more rapid stride.

Since the first half of the century that has just gone by, not to go further back, the world has strangely changed its face. Men of my generation have beheld coming on the scene by the side of and above that nature which had been known since antiquity, if not an antiphysis, a counter nature, as is sometimes said, yet a superior and in a way transcendent nature where the power of the individual is multiplied a hundredfold by the transformation, hitherto unknown or not understood, borrowed from light, magnetism and electricity. Nor is this all. Let us rise to a loftier and more fruitful range of ideas. From the deeper knowledge of the universe and the physical and moral constitution of man there results a fresh conception of human destiny governed by the fundamental ideas of human solidarity between all classes and all nations. In proportion as the ties uniting the peoples are multiplied and made tighter by the progress of science and the unity of doctrines and precepts which science deduces from the facts which it notes and which it imposes without violence, yet relentlessly, upon all convictions, these ideas have assumed a growing and more and more irresistible importance. They are tending to become the purely human bases of moral life and of the politics of the future. Hence the *rôle* of *savants* as individuals and as a social class has constantly grown in modern States.

But our duties towards other men grow at the same time, let us never forget that. Let us proclaim it in this enclosure, in this palace of French science. It is for no selfish satisfaction of our private vanity that to-day the world does homage to the *savants*. No! It is because it is aware that a *savant* really worthy of the name devotes a disinterested life to the great work of our epoch, I mean to the amelioration, too slow, alas, to our mind, of the lot of all, from the rich and fortunate to the humble, the poor, the suffering. This was what nine years ago in this very hall the State and the authorities affirmed by honouring Pasteur. This is what my friend Chaplain has sought to express on this fine medal which the President of the Republic is to offer me. I know not if I have completely fulfilled the noble ideal traced by the artist, but I have striven, at all events, to make it the object and the end, the governing aim of my existence.

The medal (or rather *plaque*) with suitable inscription was then presented to M. Berthelot by M. Loubet, the President of the Republic, and, according to continental fashion, the ceremony was concluded with a fraternal embrace.

Such is a brief account of the proceedings at this very interesting ceremony; and one is led to seek for analogies in our own country. The Kelvin jubilee at Glasgow and the Stokes jubilee at Cambridge may be cited as events of a similar character; but in France the ceremony appeared to be of greater national importance, owing to the presence of the Head of the State, the Ministers and the Ambassadors. In his reply M. Berthelot alluded humorously to the former position of science; it was regarded as a harmless pursuit, carried on by amateurs and men of leisure at the charge of the working classes, for the amusement and distraction of those favoured by fortune; it has now become one of the most potent influences for civilisation that the world has known, and will ever retain that position. Is it possible that in England the former view of science still retains some hold on the people, and that in France this aspect of science has long been outlived? Whether this be so or not it is certain that all Englishmen will join with the whole French nation in congratulating M. Berthelot on the completion of so many years of work, and will wish him health and a long life during which he may enrich the world by further investigations into the wide domain of Nature.

BERTHELOT, AND THE METALS OF ANTIQUITY.

THE metals of antiquity are among the many subjects which, from time to time, have been studied by M. Berthelot. It is principally by two different methods that he has investigated the matter: (1) the writings of ancient alchymists, (2) the analysis of metallic objects sent him by modern explorers. In 1885 Berthelot published a handsome volume, "Les Origines de l'Alchimie," in which he described his researches among the Greek papyri, and the still older documents of the Egyptian, Chaldean, Jewish, Gnostic and Chinese philosophers. In succeeding years he brought out several volumes under the title of "Collection des Anciens Alchimistes Grecs," under the auspices of the Minister of Public Instruction.

By far the most important for the present purpose is the collection of papyri at Leyden. The Papyrus X is more especially chemical. It dates from the end of the third century, but contains the lore of earlier times. It is described in fairly full detail in the *Annales de Chimie et de Physique*, 1886, vol. ix. Berthelot shows that the earlier alchemy was not founded upon purely chimerical fancies, but rests upon positive experiment, by which the adepts made imitations of gold and silver and precious stones, or taught how to increase their weight. In interpreting these ancient writings we are met with a great difficulty in fixing the meaning of the terms used for the metals and gems and the preparations made from them, the vagueness of the language being augmented by the idea that these substances were susceptible of transmutation into one another, and also by the Platonic doctrine of a primary matter from which everything may be derived. In this particular papyrus there are no less than 101 receipts for making gold, asèm (electrum), silver, &c., and the processes to be adopted. These are described by Berthelot as being genuine and definite, and not overlaid with fanciful notions; but the later philosophers and commentators were strangers to practical work and governed by mystic ideas: thus there was supposed to be a connection between the seven known metals and the seven planets, seven colours and seven transmutations. The later alchymists threw their energies into the search after the philosopher's stone which was to transmute baser metals into gold.

More important, perhaps, than his studies of the ancient manuscripts has been the prominent part which Berthelot has taken in examining chemically the metallic objects which have been unearthed by the great explorers of the present day. These researches are being carried on over the greater part of the countries bordering the Mediterranean and extending to the Persian Gulf. It is hardly necessary to say that they are enabling us to picture to ourselves these great nationalities of old in a way that was never before possible. The part that Berthelot has taken is not that of an explorer, but that of a scientific analyst; and it has been mainly confined to the metals employed in these ancient civilisations. He commenced by examining different Assyrian objects from ancient Chaldæa, some from the palace of Sargon at Khorsabad, others from the mounds of Tello excavated by M. de Sarzec, now in the museum of the Louvre. M. Place had found in the palace of Sargon a stone coffer containing votive tablets, covered with cuneiform inscriptions giving the date of foundation of the palace as B.C. 706. Of the four now in the museum of the Louvre, one is of gold, another of silver, a third of bronze and the fourth of the rare mineral crystallised carbonate of magnesia. Judging from the inscriptions two of the other tablets are believed to have been of lead and tin. The discoveries at Tello consisted of a vase of antimony, a metal which had subsequently been lost sight of for many centuries; a tablet of metallic copper, much corroded, but free from tin; and a little figure of pure copper, bearing the name

of King Gudea, which fixes its date somewhere about 4000 years before the Christian era. This led Berthelot to speculate why these specimens were made of copper instead of the harder bronze, which, so far as his experience had then gone, was used by all the ancients. He applied to Maspero for some specimens of the oldest copper of which the date could be identified. Maspero recommended to him the so-called sceptre of Pepi I., an Egyptian king of the sixth dynasty, 3500–4000 B.C. This was in the British Museum, but, through the good offices of M. Waddington, it was placed in the hands of M. Berthelot with permission to analyse a small portion from the interior. It proved to be of pure copper. It was a natural supposition that tin was unknown in that remote age; and this was confirmed by the discovery in Chaldæa of some little figures serving to support votive tablets, associated with bricks that bore the name of King Ourmina, who is supposed to have reigned 4000 years B.C. They were also of copper, without either tin or zinc.

In the meantime Prof. Flinders Petrie had been carrying on his excavations in Egypt and had asked me to analyse some copper tools and utensils from early tombs and other ruins. They proved to contain little or no tin, though many of them contained arsenic. Evidence of the gradual transition from the use of pure copper to that of copper alloyed with tin was accumulating from various quarters, but the most striking, perhaps, was that furnished by Tell el Hesy, the Lachish of scripture. It was explored by Mr. F. J. Bliss, and is described in his book entitled "A Mound of Many Cities." The lower portion of this mound represents the Amorite city, dating about 1700 B.C.; it contained large weapons of war made of copper without admixture of tin. Above this are the remains of the Israelitish city, where the copper is replaced by bronze, till in the upper layers of the mound the bronze is gradually replaced by iron. Greece has also furnished its contributions. The analyses of Roberts-Austen, Damour and others had shown that the implements first used at Tyryns, Mikenai and other towns were of copper with little, if any, admixture of tin; and similar evidence is coming forward from Cyprus, Crete and other quarters. At Hissarlik, the reputed Troy, the analysis of the objects found in the first and second cities showed that they were made of copper with mere traces of tin, while in the third and more recent cities the copper was mixed with varying amounts of tin, from 4 to 8 per cent. or thereabouts.

These researches were followed by an important paper in the *Annales* of 1895, in which Berthelot discussed the nature and origin of the metals employed by the ancient Egyptians of various epochs, especially copper, tin, gold and silver. The general result was that up to the sixth dynasty the copper used was practically what they obtained from the ores; after this the copper was mixed with small quantities of tin, rarely exceeding 6 per cent. At about the twelfth dynasty 10 per cent. became the usual proportion, forming a very serviceable bronze, but occasionally as much as 16 per cent. was used.

In the same paper he investigates the cause of the "sickness" of copper objects in our museums. They often fall to pieces through the formation of atacamite, a cupric oxychloride. This is started by the presence of chloride of sodium in the soil and the carbonic acid and oxygen of the air, and is a curious and complicated case of continuous chemical action.

It became a matter of interest to explore the ancient workings for copper, turquoise and hæmatite in Wady Maghara in the Sinaitic peninsula, which is known to have been a source of supply in the time of the third Egyptian dynasty. M. de Morgan made a careful search, at M. Berthelot's instigation, and found not only specimens of the ores, but also remains of the tools that had been used. The mines are believed to have been abandoned about the time of the eighteenth dynasty, in consequence of the poverty of the ores. The tools were of copper, hardened sometimes by a little tin and at other times by arsenic.

More recently Berthelot has examined some copper objects found at Tello, believed to be of very high antiquity. One was a huge lance of very red metal, the others were adzes and hatchets. They were almost pure copper. It may be an open question whether any attempt was made at this period to harden copper by the introduction of other metals.

From the palace of Sargon there were also obtained objects of gold foil, which was not adulterated with copper or lead, but contained a considerable amount of silver; this, however, may simply indicate that as native gold commonly contains more or less silver, it had been used in the state in which it was found without any intentional admixture. Berthelot also tested some gold objects from Egypt, the one dating from the sixth and the other from the twelfth dynasty, and found the amount of silver varied from 3·2 to 4·5 per cent., while the gold of the Persian period was practically pure.

But a more ancient chapter of Egyptian archæology was opened by the recent researches of M. de Morgan, late Director-General of Antiquities in Egypt. He explored an enormous tomb of a very ancient king, which he supposes to be that of Menes, of the first dynasty, approximately 4400 B.C. Among the objects found here were a long bead and two or three other morsels of metal, which M. Berthelot certifies to be of gold, together with some articles in copper. Further explorations at or near Abydos, by M. Amélineau, have shown the existence of tombs of kings about the same period containing many copper utensils, which M. Berthelot found to be of almost pure metal, but sometimes containing a little arsenic.

These tombs are now being very carefully explored by Prof. Flinders Petrie, and the results are published by the "Egyptian Exploration Fund" in three large volumes, "Diospolis Parva," and "The Royal Tombs of the Earliest Dynasties," parts i. and ii. It would appear that in these prehistoric times the metals mostly used were gold and copper; objects made of silver and lead are found, but they are rare.

As gold occurs native and is of a striking colour, we need not wonder that it attracted the attention of men in the very earliest periods. It is astonishing the large amount of exquisite gold jewellery, inlaid with gems, that has been found, not only in the tombs of Queen Ahhotpu and of the four princesses buried at Dahshur about 2350 B.C., but in these far more ancient royal tombs. In one of them Flinders Petrie found four gold bracelets encircling the arm bone of a royal personage, presumably the wife of King Zer. These are made of gold, set with turquoises and amethysts, and so beautifully wrought that the soldering cannot be detected by the eye. My analysis of the gold foil found in three of these tombs showed that it contained about 13 per cent. of silver, and was evidently the pale gold commonly known in the Levant. The gold worked in the Nubian mines appears to have been of a purer quality.

The last paper that has been communicated by Berthelot contains a description of a very curious case, or shrine, found at Thebes. It is of the time of Queen Shapenapit, daughter of King Piankhi, who lived in the latter part of the seventh century B.C. This inlaid case is remarkable as containing, in addition to the ordinary metals of the time, a small piece of crude platinum, weighing between five and six milligrammes. It had evidently been worked with the hammer, and had probably been mistaken by the artificer for silver.

Though not himself one of the explorers in the field, Berthelot must ever be remembered for the important part he has taken in drawing attention to, and interpreting the results of their wonderful discoveries.

J. H. GLADSTONE.

THE USE OF THE WIRE SAW FOR QUARRYING.

PROF. C. LE NEVE FOSTER has conferred a great benefit on the Welsh mining industry by directing attention to a new method of slate-mining recently tried in the Pyrenees. At Labassère the wire saw is employed to make horizontal cuts across the inclined beds of slate, severing off great blocks without blasting. Believing that a similar system could be employed with advantage in North Wales, Prof. Le Neve Foster recommended that Mr. G. J. Williams, H.M. Assistant Inspector of Mines, should study the question on the spot. The Home Secretary having acceded to this suggestion, Mr. Williams has drawn up a very valuable report, which is published as an appendix to Prof. Le Neve Foster's annual report to the Home Office for the year 1900. The investigation clearly shows that slate might be worked in many quarries in North Wales by the wire saw method with conspicuous advantages. There would be lessened blasting, fewer falls of ground, less waste of good rock, reduced cost of working, less cost of explosives, a saving in the cost of unproductive work, a saving in the cost of removing rubbish, no need of quarrying worthless rock in underground workings, and the cost of examining and securing the roofs and pillars would be done away with.

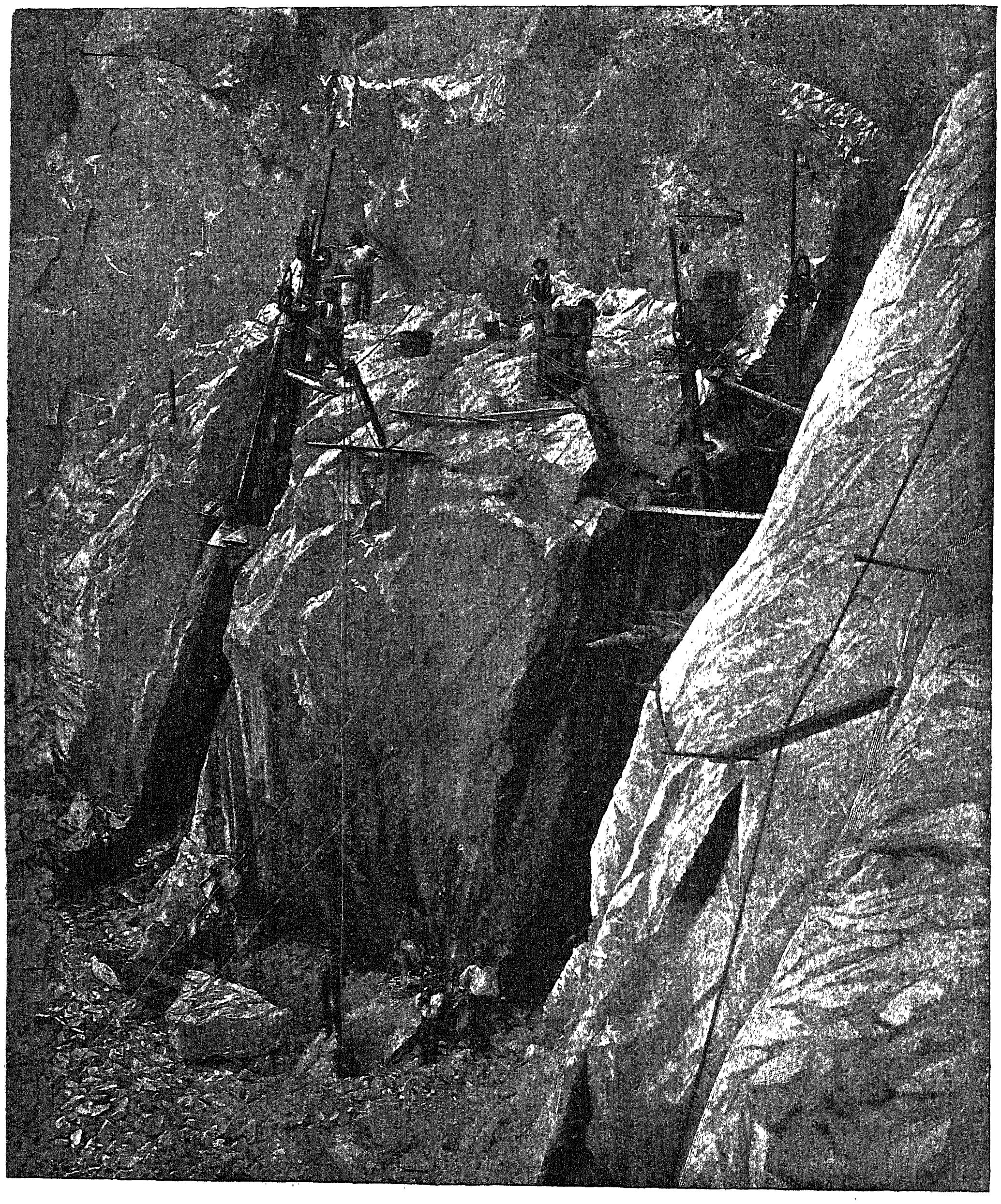

FIG. 1.—Use of the wire saw at Carrara.

The helicoidal wire saw has been employed for quarrying marble in Belgium and in Italy for some years. It is an endless cord, composed of three hard wires twisted together, which is made to travel along by machinery and

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is fed continuously with sand and water, the sharp particles of sand gradually cutting a groove. As the groove is deepened the cord must necessarily be kept applied to the rock. This is effected by guiding-pulleys mounted in pits sunk at the ends of the proposed cut. These pulleys must be at least 20 inches in diameter, and the pits somewhat larger. For sinking these pits there are employed in some Belgian quarries a rotative borer composed of a steel tube cutting an annular groove. The wire saw was applied at Carrara for subdividing blocks of marble, but the impracticability of using the revolving cylinder or hand labour for sinking inclined pits was an obstacle to its further use. The difficulty was, however, overcome by Mr. A. Monticolo, who invented an ingenious appliance which he termed a penetrating pulley, with which it is possible to replace the somewhat costly pit by a bore-hole 3 inches in diameter. The penetrating pulley consists of a disc 20 inches in diameter and $\frac{1}{4}$ inch thick, with a semicircular groove round its periphery deep enough to take half the thickness of the wire, the other half projecting. The disc is mounted on a pivot and is supported by a hollow steel shaft of slightly smaller diameter than the bore-hole. To the shaft is attached a series of tubes of equal diameter forming a column that may be lengthened at will, in the interior of which is a fine tube serving for the lubrication of the pivots. As the cut deepens the pulley is fed down automatically by means of an eccentric. For cutting a groove, two bore-holes, to receive the shafts carrying the axes of the pulleys, are first made by hand or by the diamond drill.

The pulley was first applied in March 1898 at the Campanile quarry, Carrara, where cuts have been made 50 feet long and 16 feet deep, inclined at an angle of five degrees from the horizontal. The highly satisfactory results obtained with the penetrating pulley serve to show that there is a great saving of expense by the substitution of bore-holes for pits, far less waste of valuable marble, and increased rapidity of quarrying and consequently increased output.

Almost simultaneously with the publication of Mr. Williams' report, the *Revue Générale des Sciences* published an exhaustive article by Mr. J. Boyer on the present condition of the French marble industry. This article is profusely illustrated and contains a large amount of information relating to the use of the wire saw. From this article the two illustrations accompanying this note have been borrowed.

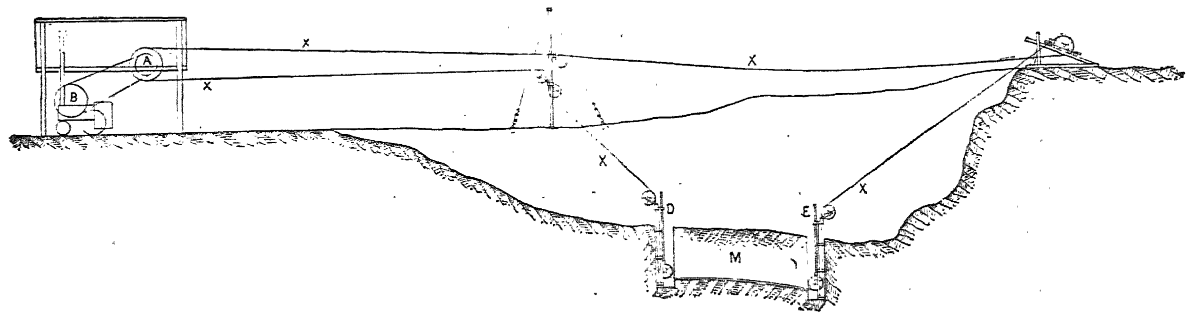

FIG. 2.—Installation of the helicoidal wire saw at a quarry. X, helicoidal wire; A, fixed pulley; B, motor; C, tightening arrangement; D, E, wire saw and grinding pulleys; M, block of marble being quarried.

NOTES.

DR. F. McCLEAN and Sir John Murray, whose names were included in the list of the new Council of the Royal Society given in NATURE of November 14, are unable to serve; and the two Fellows recommended for election in their places are the Right Hon. Sir John Gorst and Prof. H. H. Turner.

SIR WILLIAM ROBERTS-AUSTEN, K.C.B., F.R.S., will deliver the tenth "James Forrest" lecture at the Institution of Civil Engineers on April 17, 1902, the subject being "Metallurgy in Relation to Engineering."

THE governing committee of the Allegheny Observatory has decided to erect a 30-in. reflector at that institution as a memorial to the late Prof. Keeler. As it is expected that the funds subscribed will exceed the estimated cost of the instrument (2000*l.*), the balance will be used either to found a general fellowship for the study of astrophysics, or the award of a Keeler medal for work in the same field.

THE Royal Society of Public Medicine of Belgium has awarded Prof. Corfield, of University College, London, its bronze medal in recognition of his devotion to public health work.

A SUCCESSFUL kinematograph of the Severn bore was exhibited by Dr. Vaughan Cornish at the meeting of the Royal Geographical Society on Monday. This is, we believe, the first time that the impressive movement of a tidal bore has been recorded by photography and the phenomenon reproduced before an audience by a series of moving pictures.

A NEW Highland meteorological station has been established at Achariach in Glen Nevis, $4\frac{1}{2}$ miles S.E. of the Low Level Observatory at Fort William, and $2\frac{1}{4}$ miles S.W. of the observatory on Ben Nevis. The station is about 150 feet above sea-level, and the observations in the valley will be especially interesting in connection with the study of descending currents of cold air from the glens in the vicinity.

THE Council of the Royal Meteorological Society has designated Dr. Alexander Buchan, F.R.S., as the first recipient of the Symons gold medal in recognition of the valuable work which he has done in connection with meteorological science. This medal, which is to be awarded biennially, was founded in memory of the late Mr. G. J. Symons, F.R.S., the distinguished meteorologist and originator of the British Rainfall Organisation. The medal will be presented at the annual meeting of the Society on January 15, 1902.

A REUTER telegram announces that the *Gauss*, with the German Antarctic Expedition on board, arrived at Cape Town on Saturday morning, after being six weeks overdue. After leaving Hamburg on August 11 the *Gauss* touched at Las Palmas, and St. Vincent Islands. Deep-sea soundings were taken towards the west, but the ship did not go so far as the American coast. The *Gauss* was under sail the whole time, and the scientific observations made are said to be most satisfactory. The vessel will remain at Cape Town for ten days, and will then proceed to Kerguelen Island.

ON Monday evening M. Santos Dumont was entertained at dinner by the Aëro Club of the United Kingdom. The chair was taken by Major-General Lord Dundonald, and among the company present were the Brazilian Minister, Lord Suffield, Sir Norman Lockyer, Colonel Templer, director of military ballooning, Sir J. Crichton Browne, Prof. D. S. Capper, Colonel R. E. B. Crompton, R.E., Sir V. Kennett-Barrington, Prof. John Perry, Dr. Boverton Redwood, the Hon. C. S. Rolls and Mr. R. W. Wallace. In acknowledging the toast of his health, M. Santos Dumont said that he hoped in a few months' time to make some trials with a dirigible air-ship above London.

AN illustration of the way in which a disease present in one species or race in a mild form may produce most severe effects when introduced into a region inhabited by another race, has been sent to us by Prof. T. D. A. Cockerell. It appears from trustworthy reports that the natives of western Alaska are rapidly disappearing from the effects of an epidemic of measles. Dr. Moore, assistant surgeon of the United States quarantine service, states that at least one-third of the native population at Cape Prince of Wales, Nome, Port Clarence, St. Michael, Kuskokwim, Unalaska, Pribyloff Islands, Nunivak Island and St. Lawrence Island, and those along the Yukon River, have suffered from the effects of the epidemic, which at first was thought to be smallpox, but upon investigation proved to be measles. The epidemic originated at Holy Cross in north-eastern Siberia, and from that point it was carried to places visited by whalers, and the whalers carried the disease to Alaska. Dr. Moore reports the condition of the natives as being most pitiable.

A PAPER on "Fairies, Apparitions, Visions and Hallucinations" was read by Sir Lauder Brunton at a meeting of the Medico-Psychological Association last week. At the outset, attention was directed to the fact that there is considerable variation in the acuteness of the senses of different people. Thus some persons perceive blue flames in the fire in winter and some persons hear the shrieks of bats, whilst others are sensible of neither. In the same way there are people who feel things which others do not feel. Apparitions are probably due to abnormal conditions of the apparatus required for the reception of external impressions. The vessels inside the brain may be capable of contraction, like those outside, and in that case there would be anæmia of parts of the brain and consequently affections of vision, hearing, smell and taste. Epilepsy is connected in the minds of psychologists with migraine. In many people migraine is preceded by a vision of zigzags, rather like a procession. A troop of spirits in this form appears in Doré's illustrations to the "Inferno." It was suggested as not unlikely that both Dante and Doré suffered from headache of this kind. Stories of fairies might partly be referred to visions as well as to the aboriginal race mentioned by Prof. Rhys. Speaking of Mahomed, Sir Lauder Brunton described his visions, trembling fits and convulsions, and said it was curious to speculate how different might have been the course of the world's history if the prophet had been thoroughly dosed with bromide of potassium.

SIR WILLIAM PREECE, K.C.B., F.R.S., covered a wide field in the address which he delivered on November 20 at the opening of the new session of the Society of Arts. He surveyed the most prominent points of scientific progress during the nineteenth century, and from the trend of advancement suggested some developments of the immediate future. The great scientific discoveries of the past century dealt with in the address were (1) the principle of evolution; (2) the atomic structure of matter; (3) the existence of the æther and the undulatory theory of light; (4) the principles of electromagnetic induction and electrolysis; (5) the principle of the conservation of energy. Limitations of space prevent us from printing the address in full, but the following are a few extracts from it. The trend of research at the commencement of the twentieth century is to prove that the basis of all matter is fundamentally the same, and that the true atom has not yet been reached.—The criterion of true advance in knowledge is the possession of standards and of means of accurate measurement. We commence the twentieth century remarkably well equipped with both these requisites. The engineer has only to take care of his "Joules," or units of energy, and his machines will take care of themselves.—The only excuse for disaster due to magnetic disturbance is ignorance. The stars are always with us for guidance and comparison. Magnetic science must be maintained by well-equipped laboratories, by continuous observations, by the distribution of reports and by up-to-date records and corrections of charts. We seem to have learnt all we can of magnetism, and we commence the twentieth century without any indication of a new directing force. We have local magnetic disturbing elements to measure, and certain dangers due to storms, snow, rain and fog to remove. We want better warning of approach to land, and better communication between ship and ship and ship and shore. The twentieth century is bound to see great developments in this direction. In conclusion, Sir William Preece remarked:—"I hope that I have succeeded in showing that progress in all branches of life is due to certain motive causes working on the principle of evolution; that these causes are within the reach of our observation; and that they have only to be discovered, so that, by their encouragement, we may secure, during the coming century, greater and further advances in civilisation and knowledge."

MR. LANGDON, in his presidential address to the Institution of Electrical Engineers on Thursday last, dealt with the applications of electricity in railway engineering. Although in so doing he passed to a large extent over the same ground as he covered in his paper on the supersession of the steam by the electric locomotive in November 1900, he treated the subject from a more general and less technical standpoint. Hitherto electricity has played a small, but indispensable, part in the working of steam railways, for telephone, telegraph and lighting purposes; but Mr. Langdon realises that the problem of the conversion of our steam railroads is one pressing for immediate attention. The magnitude of the railway interests is so enormous that it is necessary to give the question the most careful consideration, or disastrous results may accrue. The reckless investment of capital in electric railways to compete with existing lines is not likely, Mr. Langdon points out, to be profitable for shareholders in either concern, and he seems to deprecate competition of the kind foreshadowed by the projected new electric railway between Manchester and Liverpool. It is, however, for the railway companies themselves to show that they are on the alert and are prepared to meet the growing demands of the country; for if the necessary reform does not come speedily from within, it is they, we think, who will be likely to suffer disaster. Electrical engineers have before them a work compared with which their past achievements are but trifling; in carrying it out let them by all means go carefully, but do not let them consider that synonymous with going slowly.

AMONG the notes in *The Engineer* (November 22) a remarkable motor-car performance is recorded. M. Fournier, the well-known French motorist, drove a 40-horse-power petrol car one mile in 51⅘ seconds, approximately 70 miles per hour. The tract was a straight and level piece of road known as the Ocean Parkway, New York.

A PAPER of much interest on the balancing of locomotives has just been read before the Institution of Mechanical Engineers

by Prof. W. E. Dalby. As is well known, although there are some engines with their reciprocating and revolving parts *unbalanced,* the counterpoising of the various parts forms a most important item in the designing of the engine, and a point which, if neglected, is afterwards easily discernible on the footplate. The paper, which is divided into nineteen separate articles, deals with the subject in a very lucid manner, and each article is thoroughly treated. We find taken as examples two typical English engines (a passenger and goods on the L. and Y. Railway) and an 8-coupled engine, class E Baldwin Company of America. In the article in which the distribution of the reciprocating mass between the coupled wheels is discussed, three figures are of special interest, being diagrams showing: (1) All revolving mass and two-thirds reciprocating mass in driving-wheel (only); (2) all revolving mass and two-thirds reciprocating mass equally distributed (on all wheels); (3) all revolving mass and all reciprocating mass equally distributed (on all wheels). In dealing with four-cylinder locomotives the author points out how balancing can be effected without the use of balance weights attached to the wheels, by properly proportioning the "masses" and "crank angles."

Symons's Meteorological Magazine for November contains a summary of the climate of the British Empire for the year 1900, so far as it can be represented by reports from eighteen stations distributed over various parts of the world. The highest temperature in the shade (112°·2) occurred at Adelaide on January 1; this station also registered the highest solar temperature, 170°·5. The maximum temperatures at London (95°·2 on July 16) and Toronto (98°·0 on August 6) are the highest noted for these stations since the commencement of the summary in 1877. The lowest shade temperature (−34°·8 on February 9) was recorded at Winnipeg, where the range in the course of the year was 135°·3. The driest stations were Adelaide and Fredericton (New Brunswick), where the mean humidity was 66 per cent., and the dampest station was Colombo, Ceylon, mean humidity 81 per cent. The greatest rainfall was at Calcutta, 89·3 inches, and the least at Malta, 16·1 inches.

THE pilot chart of the North Atlantic and Mediterranean for the month of December, just issued by the Meteorological Office, shows that there were still a few icebergs on the edge of the bank eastward of Newfoundland as late as October. On the great circle track to Belle Isle, and also within the Strait, there has been a perceptible diminution in the quantity of ice reported, so that from the scores of bergs sighted about July and August they have now dwindled to an occasional one. It is, however, interesting to notice in this connection that the Dundee whalers recently returned from Davis Strait report much ice blocking up the west side of the strait and drifting southward last summer, while in the early part of October what was probably a portion of the same ice was reported to be sweeping down along the Labrador coast in great quantities. There is thus some probability of the next ice season off the Newfoundland coast being an early one. Realising the importance to the mariner of a clear understanding of the laws governing the movements of cyclonic disturbances—how he should combine his observations of the wind direction with the barometric variations to obtain, under all circumstances, a fair idea of his position in the storm field, and to ascertain approximately the line of progression of the central part of the system—the article on Atlantic storm systems published in one of the earlier charts is reproduced at the commencement of the season of winter storms. An inset chart illustrates the conditions obtaining over north-western Europe during the north-westerly type of weather, that of December 1895 being in the ascendent for more than a fortnight. At this season the winds of the Mediterranean region are shown to be influenced by disturbances which follow two well-defined paths, one from the Bay of Biscay to Sardinia and away to Cyprus, the other taking a north-easterly course from about Gibraltar to Corsica and across Italy to Dalmatia.

MR. HALCOTT C. MORENO has published in the *Proceedings* of the American Academy of Arts and Sciences a paper on ruled loci in n-fold space. Corresponding to a developable and its edge of regression in ordinary space, we have the loci derived from a flat of $n-1$ dimensions whose equation involves a single arbitrary parameter, these loci representing the ultimate intersections of two, three or more flats of the family. In like manner loci corresponding to ruled surfaces are obtained from an $n-2$ flat whose equations involve a single parameter, and the further case is considered of an $n-k$ flat also involving a single parameter. Several of the conclusions obtained are analogues of results given for three-dimensional geometry in Salmon's well-known treatise.

THE accident to the aëroplane machine with which Herr Kress has been experimenting on the reservoir of the Vienna waterworks forms the subject of a critical article in the number, for November 16, of *Die Umschau*, a paper which has previously given several well-written articles on this and other systems of experimenting in aërial navigation. Herr Kress made the mistake of building the machine without waiting for the motor, and when the latter was at length obtained it was found to be a heavier one than he had ordered. This had the effect of making the apparatus top-heavy when sailing on the water on the aluminium boat which formed its car, and the accident occurred, not when the machine was going at full speed, but after the pace had been moderated and the apparatus was turning towards the bank. A small gust of wind catching the sails appears to have caused the machine to heel over to such an extent that it was incapable of righting itself. It is pointed out that stability in the water and stability in the air are quite different things, and Kress thinks that the high position of the centre of gravity would not have affected the stability of the machine if it had been supported in the air by its wings, nor would a side wind have had the same power of overturning it.

IN a recent issue of the *Proceedings* of the American Academy of Arts and Sciences (vol. iii. p. 507) Mr. E. C. Starks gives a complete list of the numerous synonyms which have been applied to the component bones of the fish-skeleton. It may be hoped that naturalists will agree to adopt the names selected by the author as the best designations of the individual bones.

TO the November issue of the *Zoologist* Capt. G. E. H. Barrett-Hamilton communicates a further note on the origin of sexual dimorphism and of nuptial weapons and ornament. In the same journal Mr. F. Cohern narrates his experiences during a bird-collecting trip to the north of Iceland, with a list of the species obtained. He speaks of the extraordinary abundance and tameness of the birds, and believes that he has obtained a new form of pipit, although this opinion does not appear to be shared by his fellow ornithologists.

THE August issue of the *Boletim* of the Para Museum contains a paper by Dr. E. Goeldi on two Brazilian rodents, one of which (*Blarinomys breviceps*) was first described from its fossil remains, but is now known also by a single recent example. The same author gives an illustrated description of the gigantic catfish of the Amazons locally known as the piraïba. In assigning to this fish a new scientific name (*Piratinga pira-aiba*) the author states that in its young state it has long since been described by Lichtenstein as *P. filamentosa.* If this be so, the new title seems superfluous.

THE whole of part iv. of vol. xiii. of the *Journal* of the College of Science of Tokio is occupied by an elaborate dissertation on the development, structure and metamorphosis of

that remarkable organism described in the larval form by Jahannes Müller in 1846 as Actinotrocha, and in the adult state by S. Wright in 1856 as Phoronis. The identification of the free-swimming Actinotrocha as the larva of the compound and stationary Phoronis is one of the discoveries for which science is indebted to Kowalewsky; but the question still remains undetermined whether the organism should be placed with the Gephyrean worms or with the Hemichordata. In spite of the numerous papers which have been devoted to this curious form, the author, Mr. Iwaji Ikeda, states that its life-history has hitherto been very imperfectly worked out, and it is to this that he has devoted much of his attention. Another point is the manner in which the free-swimming larvæ establish colonies in certain definite and limited localities. From the fact that the colonies are subject to periodical decay it is suggested that the organism annually changes its generation. It may be remarked that although in the title of the paper the name Actinotrocha is employed, in the text the family is alluded to as the Phoronidæ, while various species of Phoronis are mentioned.

NUMBER 12 of Sir George King's "Materials for a Flora of the Malayan Peninsula," reprinted from the *Journal* of the Asiatic Society of Bengal, is occupied entirely by the eleven genera of Myrtaceæ, including the ninety-six Malayan species of Eugenia.

WE have received the first three numbers of the *Bulletin* of the Imperial Botanic Garden of St. Petersburg, edited by Prof. A. Fischer v. Waldheim. The *Bulletin* is intended to appear at irregular intervals and to be devoted to original treatises, not before published, in all branches of botany, critical notices, and reports and communications from the Imperial Botanic Garden. In the present instalment the papers are in Russian, with brief French or German abstracts. They include articles on the Exoascaceæ of the Caucasus, "migrating lichens," biological observations on buckwheat, lichenological notes, &c.

THE origin and distribution of the cocoanut palm forms the subject of an interesting paper by Mr. O. F. Cook in a recent issue of the United States National Herbarium. It is contended that this most useful tree must have originated on the Pacific coast of South America and spread from thence to Polynesia and Asia. It is pointed out that all the other species of cocos are natives of South America. The cocoanut palm was found upon the Pacific coast by early Spanish explorers. Mr. Cook also claims an American origin for the banana and yam.

A RECENT number of the Australian *Town and Country Journal* is largely occupied with an illustrated account of the new mining school recently opened in connection with Sydney University. The erection of this school is largely due to the exertions of Prof. A. Liversidge, F.R.S. It is now well equipped with machinery and laboratories, and should prove of great value for training men to conduct metallurgical operations. The University of Sydney grants a degree in mining engineering, and the course of instruction given at the school is mainly in preparation for this degree.

LIEUT.-GENERAL C. A. MCMAHON contributes notes on some peridotites, serpentines, gabbros and associated rocks from Ladakh, north-western Himalaya, to the Memoirs of the Geological Survey of India (vol. xxxi. part iii.) These rocks are found intrusive in the Tertiary volcanic series. Mr. Vredenburg (vol. xxxii. part i.) discusses very fully the results of recent artesian experiments in India, pointing out that many of the so-called "artesian wells" are not fed by water under pressure. He gives records of numerous borings and concludes that artesian wells cannot be of utility in any extensive scheme of irrigation. Mr. T. H. Holland (vol. xxxiv. part i.) draws attention to a peculiar form of altered peridotite in the Mysore State, whereby a simple dunite has been changed into a breunnerite-picrolite-talc rock. He remarks that it is important to distinguish between this "primary" or contemporaneous alteration, due to the action of vapours originally contained in the magma, and the "secondary" changes that may be induced subsequently and are unconnected with the processes of consolidation.

THE publication of a ninth edition of "Stieler's Hand-Atlas" has been commenced by Mr. Justus Perthes, Gotha. The work will be issued in fifty parts, which will appear at intervals of two or three weeks.

PROF. ANDREW GRAY'S work on "Dynamics and Properties of Matter," being Part i. of his "Treatise on Physics" (J. and A. Churchill), is shortly to appear in the German language. The work of translating has been undertaken by Prof. Auerbach, of Jena.

A CATALOGUE of the Indian Decapod Crustacea in the collection of the Indian Museum, Calcutta, is in course of preparation by Major A. Alcock, F.R.S. It is proposed to issue the catalogue in three collateral and independent series, one for the Bachyura, another for the Macrura, and a third for the Anomura. The first fasciculus of Part i. has been received and contains an introduction to the monograph, and descriptions, with plates, of the Dromides or Dromiacea.

MR. JOHN HEYWOOD has published the second part of Book II. of "Machine Drawing for the use of Engineering Students in Science and Technical Schools and Colleges," by Mr. Thomas Jones and Mr. T. Gilbert Jones. The part contains forty-five plates, upon which drawings of engine and pump details are given; and descripitive text, with exercises, accompanies each plate. Students of engineering and machine construction will find the drawings of service in showing the details of engines and pumps constructed at the present time.

THE sixth part of Prof. A. Engler's elaborate monographs of the families and genera of African plants (Monographieen afrikanischer Pflanzen-Familien und -Gattungen) has been published by Mr. W. Engelmann, Leipzig, and can be obtained from Messrs. Williams and Norgate, London. The work, it will be remembered, is being prepared under the auspices of the Prussian Academy of Sciences, and when completed will be a most valuable account of the plants of the African continent. The present part deals with the Anonaceæ and is by Profs. Engler and L. Diels.

A SERIES of regional floras of India has been projected by the Director of the Botanical Survey of India, and the first part has been issued by Messrs. Taylor and Francis. In this volume Mr. T. Cooke deals with "The Flora of the Presidency of Bombay" from the order Ranunculaceæ to Rutaceæ. The increase of knowledge of the botany of the Presidency in recent years may be judged by the fact that the present part of the projected work (comprising 192 pages) contains descriptions of more than 130 species not included in Dalzell and Gibson's "Flora of Bombay," published in 1861. We propose to review the work when it has been completed.

MESSRS. G. PHILIP AND SON have recently published a pair of globes—one terrestrial and the other celestial—for the low price of three shillings. The globes are mounted on slender brass tripods, and each can be rotated on an axis. The diameter of each globe is four inches. It is, of course, not possible to represent any details upon a terrestrial globe of this size, or to find many stars by means of the celestial globe, but a young student may derive instruction from them as to the relative positions of the great land-masses of the earth and the meaning of the celestial sphere.

TEACHERS and students of botany often find it difficult to obtain the plants or other botanical material required by them for examination. A pamphlet received from Messrs. James Backhouse and Son, Ltd., The Nurseries, York, reminds us that this firm has a special scientific department for the purpose of supplying living and preserved material for use in classes or private study. Practically every specimen or preparation required in a course of botany is kept on hand ready for dispatch, and if it is not in stock it will be obtained. The facilities thus afforded for obtaining botanical material should promote the study of botany in schools and encourage investigation by private students.

SINCE the classical work of Bunsen on the cacodyl compounds, many attempts have been made to prepare monomethylarsine, the analogue of methylamine, hitherto without success. In the *Berichte* for November 9, Messrs. A. W. Palmer and W. H. Dehn give an account of the preparation of this substance in a pure state. Indications of the existence of such a compound were obtained three years ago, by the reduction of methyldichlorarsine, but as this is costly and difficult to prepare, a more suitable starting point was found in cacodylic acid. This on reduction with amalgamated zinc dust and hydrochloric acid gives the $CH_3.AsH_2$, which is separated from the hydrogen which accompanies it by passing through a U-tube surrounded by a mixture of solid carbon dioxide and ether. Monomethylarsine is a colourless, mobile liquid, which boils under ordinary atmospheric pressure at 2° C. and possesses the penetrating objectionable smell of cacodyl. It rapidly attacks indiarubber, and combines immediately with oxygen, without, however, catching fire spontaneously, in this respect differing from dimethylarsine. The production of monophenylarsine from monophenylarsenic acid is described in the same paper.

IN continuing his researches on ammonium amalgam M. Moissan has arrived at some interesting results which he describes in the current number of the *Comptes rendus*. Sodium amalgam was allowed to act upon ammonium iodide in solution in liquid anhydrous ammonia at a temperature of about −39° C. Under these conditions the sodium amalgam reacts upon the ammonium iodide and becomes more fluid, without the formation of any gas. The sodium iodide formed together with the excess of sodium were then removed by liquid ammonia at a temperature of −40° and then with ether at −80° C. The solid ingot thus produced was then placed in a tube kept at −90° and connected with a mercury pump. It was found that a perfect vacuum could be maintained in the apparatus without any gas being given off by the ingot. The temperature was then allowed to rise, when a mixture of ammonia and hydrogen gases in the proportion of two of the former to one of the latter was given off. All these facts would appear to point to the conclusion that the radical NH_4 is actually present in the metallic mass prepared at −39°, but M. Moissan believes that this is not really the case, there being a possibility that a metallic ammoniacal hydride is formed. He has found that when sodium amalgam reacts with a solution of ammonia in water, there is a slow evolution of gas without foaming. If, however, sodium hydride in solution in sodium amalgam is placed in the same liquid, there is at once a foaming mass produced, which may last for two or three days. Further experiments are promised in this direction.

THE additions to the Zoological Society's Gardens during the past week include a Chacma Baboon (*Cynocephalus porcarius*) from South Africa, presented by the Lord Dunleath; a Toque Monkey (*Macacus pileatus*) from Ceylon, presented by Mrs. de Koop; a White-crowned Mangabey (*Cercocebus aethiops*) from West Africa, presented by Mr. S. J. Dean; a Grecian Ibex (*Capra aegagrus*), South-East European, presented by Mr. B. A. Isaac; a Common Water Buck (*Cobus ellipsiprymnus*) from South Africa, four Viscachas (*Lagostomus trichodactylus*) from Buenos Ayres, a Black-headed Oriole (*Oriolus melanocephalus*), an Orange-headed Ground Thrush (*Geocichla citrina*), two Indian Shamas (*Cittocincla macrura*) from India, deposited.

OUR ASTRONOMICAL COLUMN.

ASTRONOMICAL OCCURRENCES IN DECEMBER.

Dec. 3. 13h. Juno in conjunction with moon. Juno 0° 14′ S.
4. 22h. Venus at greatest elongation, 47° 15′ E.
9. 9h. Uranus in conjunction with the sun.
11–13. Epoch of the Geminid meteoric shower (radiant 109° + 33°).
13. 23h. Mars in conjunction with Saturn. Mars 1° 18′ S.
14. 6h. 43m. to 7h. 39m. Moon occults β Capricorni (mag. 3·4).
15. Venus. Illuminated portion of disc = ·445.
Mars. Illuminated portion of disc = ·980.
16. 9h. 46m. Minimum of Algol (β Persei).
17. 3h. Mars in conjunction with Jupiter. Mars 0° 52′ S.
18. 7h. 24m. to 8h. 9m. Moon occults λ Piscium (mag. 4·7).
19. 6h. 35m. Minimum of Algol (β Persei).
22. 1h. Sun enters Capricornus. Winter commences.
22. 2h. Neptune in opposition to the sun.
23. 5h. 53m. to 6h. 12m. Moon occults ε Tauri (mag. 3·7).
27. 10h. 42m. to 11h. 50m. Moon occults A^2 Cancri (mag. 5·8).
31. 9h. Juno in conjunction with the moon. Juno 0° 18′ N.

LEONID METEORS, NOVEMBER 1901.—Mr. G. C. Thompson sends the results of observations at Penarth of Leonid and sporadic meteors on the nights of November 14–15 and 15–16. Between November 14, 11.35 p.m., and November 15, 1.55 a.m., four bright Leonids were observed, all exhibiting characteristic green streaks, four probable Leonids, without streaks or train, one of doubtful origin, and four sporadic meteors. On the night of November 15–16 no meteors were observed until after midnight, but between 12.20 a.m. and 12.50 a.m. one bright Leonid was seen, two probable Leonids, and four sporadic meteors.

Mr. J. R. Henry, writing from Dublin, says "there was a distinct display here of meteors from the Leonid radiant on the morning of November 15. During a watch kept from 10.20 to 11.15 on the night of November 14 only three meteors of the first or second magnitude were observed. The first was a fine bolide which passed a few degrees to the right of Gemini towards Leo at about 10.55. The watch was resumed at 12 o'clock under somewhat restricted conditions as regards position, which faced the east. From 1 to 3.30 meteors shot steadily from the Sickle at the rate of about twelve per hour for those of the first or second magnitude. No sporadic shooting stars above the third magnitude were noted in this part of the sky. The brightest meteor, equal to Sirius, was observed at 2.40 a.m. It passed somewhat slowly from the Sickle to a position 20° below Procyon. A brilliant flash illuminated the eastern horizon at 3.30 a.m."

MOTION OF THE GREAT RED SPOT ON JUPITER.—In *Popular Astronomy*, vol. ix. pp. 448–490, Mr. W. F. Denning discusses the observations secured of the position of the great red spot during the period 1894–1901, illustrating the result by a curve showing the drift in longitude of about 50° in that time. An observation made on 1901 September 5 is interesting from the fact that it was exactly seventy years after that of 1830 September 5, when H. Schwabe at Dessau first drew the hollow. During this interval of 2,208,980,280 seconds the planet has made 61,813 rotations, giving a mean period of 9h. 55m. 36·56s.

The observations at Bristol have mostly been made with a power of 312 on a 10-inch reflector.

PRELIMINARY INVESTIGATION OF THE DIAMETER OF MARS.—Prof. T. J. J. See, in continuation of his work on planetary diameters, gives the results of old and new measures of the disc of the planet Mars in *Astronomische Nachrichten*, Bd. 157, No. 3750. The measures published from 1651-1901 are tabulated and divided into two categories, according to their being determined with the wire micrometer or the heliometer. The values obtained in these two ways are markedly different, the mean diameter from the wire micrometer being 9·678, that from the heliometer 9·338, at mean distance. This discrepancy has been usually attributed to irradiation. A considerable number of experimental trials have been made at the Washington Observatory in order to get a trustworthy value for the correction due to this cause, and the results obtained from a recent series of determinations, using liquid screens in the eyepiece, are given. The polar diameter of the planet is thus estimated as

$$9''\cdot222 \pm 0''\cdot013$$
$$= 6687 \text{ km.} \pm 10 \text{ km.}$$

Assuming an oblateness of 1 in 200, the equatorial diameter may be taken as $= 9''\cdot30 = 6743$ km.

DEFINITIVE ORBIT ELEMENTS OF COMET 1899 I.—Mr. C. J. Merfield, of Sydney, has computed the definitive elements of the orbit of this comet from the available observations during the period 1899 March 4–August 10.

Elements.

Epoch of osculation 1899 March 12.
T = 1899 April 12·978010 G.M.T.

$$\left.\begin{aligned} \omega &= 8^\circ\ 41'\ 46''\cdot48 \\ \Omega &= 24\ 59\ 59\cdot93 \\ i &= 146\ 15\ 30\cdot29 \end{aligned}\right\} 1900\cdot0$$
$$\log q = 9\cdot5139795$$
$$\log e = 0\cdot0001521$$
$$e = 1\cdot00035029.$$

In the course of the article many hitherto isolated descriptions of the varying appearances of the comet during its period of visibility are brought together. Throughout March 1899 the comet appeared as a nebulous mass 4′ or 5′ of arc in diameter, with a central condensation. After perihelion passage many changes commenced to be presented. Prof. Perrine, at Lick, observed the nucleus to be double, and obtained measures of the components, the distance between them increasing from 12″–18″ of arc during the period 1899 May 11–14. This feature was later confirmed by Prof. Barnard, who measured the two nuclei with the Yerkes refractor, and found the separation to increase from 29″–38″ of arc during 1899 May 20–23. This increasing distance would appear to be partly due to an actual separation of the two portions of the nucleus, but this has not yet been examined sufficiently to be decisive.

On 1899 June 5 a considerable increase of brightness was noticed by many observers, the nucleus being estimated by Dr. Hartwig to be 9·5 magnitude and the whole comet about 5·0 magnitude, the diameter of the coma being about 12′ of arc. Dr. Schorr recorded that the nucleus appeared to be excentrically situated. (*Astronomische Nachrichten*, Bd. 157, No. 3747-48.)

THE CHEMISTRY OF THE ALBUMINS.

THE albumins, using this term in its widest and most general sense, form almost the last of the great natural groups of substances which have hitherto presented an impenetrable front to the attack of the synthetic chemist. With the progress of organic chemistry, some, at all events, of the alkaloids, the sugars and the glucosides have yielded up their secrets of constitution and configuration so fully that their synthetic preparation has crowned the labours of the investigator and confirmed the deductions he has drawn from a study of the reactions and transformations of the products found in nature. But the chemistry of the albumins, in which lie locked up the secrets of animal and vegetable growth, of health and disease, perhaps even of life and death, has not yet progressed beyond the preliminary stages of investigation—the establishment of criteria of purity and methods of separation, and the study of reactions and decomposition products. These first studies have, indeed, added much of great value and importance to our knowledge of this supremely interesting class of compounds, but the very complication of the results obtained has produced rather a feeling of mental bewilderment than one of increased insight and comprehension.

In these circumstances the report of a lecture by Prof. Kossel on the "Present Position of the Chemistry of the Albumins," which is contained in a recent number of the *Berichte*, will be of special interest to both physiologists and chemists. The lecture forms one of that series of addresses on special branches of chemistry, delivered by the foremost of those engaged in active work upon them, which has been for some years one of the most valuable and attractive features of the activity of the German Chemical Society, and one well worthy of imitation.

From the admirable account of the subject there given, it appears that in several directions important advances have been made, and we propose here to indicate shortly the nature and tendency of these, after first pointing out some of the difficulties which have not yet been overcome.

In the first place, no entirely satisfactory criterion of chemical individuality has yet been found for the albumins, all the prevailing methods which the chemist has been forced to employ for their purification and separation—precipitation by various reagents, coagulation, differences of solubility, and even crystallisation—being pronounced insufficient to guarantee the individuality of the product. This is due partly to the colloidal nature of these substances, a property which is most probably conditioned by their enormously high molecular weight, and partly to their great tendency to form loose compounds with other substances, and especially with such as occur along with them in the tissues of plants and animals.

A second difficulty lies in the great number of different substances belonging to this class which have been prepared, even with the imperfect methods at present at our command, and in the bewildering complexity of the products of decomposition obtained from many of them by such simple means as hydrolysis.

One instance may suffice to illustrate this point and at the same time serve as an enumeration of the various chemical groups obtainable from a complicated member of the class. Certain nucleoproteids yield on hydrolysis the following products, each of which represents a different group in the molecule of the mother substance:—arginine, histidine, lysine, leucine, asparaginic acid, glutamic acid, pyrrolidinecarboxylic acid, the purine bases, thymine, phosphoric acid, two groups containing sulphur, and separate groups yielding furfuraldehyde, skatole and lævulinic acid; most of these groups are, moreover, with great probability contained several times over in a single molecule.

Fortunately, however, all the albumins are not as complicated as this, and it is by the discovery of simpler members of the class and by a quantitative study of the products of their decomposition—researches almost entirely due to Kossel and his coworkers—that the most substantial advance of recent years has been made. These, the least complex albumins yet known, have been obtained from the spermatozoa of certain fish and have received names denoting their origin, *e.g.* salmin, sturin, clupein, &c. They possess strongly basic properties, turn red litmus blue and form salts with acids, yet unite with this chemical activity the high molecular weight and colloidal properties of the albumins, and have hence been termed the *protamines*. Their comparative simplicity is, however, shown by the nature of the products formed from them by hydrolysis.

The more familiar and complex members of the group, such as casein or egg-albumin, yield on hydrolysis a large number of different products, which may, however, be grouped in four main classes:—

(1) A compound capable of yielding urea. This is invariably found in the form of *arginine*, or guanido-amidovaleric acid, a compound which may be regarded as at the same time a derivative of urea and of diamidovaleric acid.

(2) The diamido-acids, at least three members of which have been recognised, including the group contained in arginine.

(3) The monamido-acids, ten or eleven different acids having all been found.

(4) A number of other products such as ammonia, furfuraldehyde, pyrrolidinecarboxylic acid, humus-like substances, &c.

The proportions in which the representatives of these classes are produced vary greatly for the different albumins, casein, for example, yielding very little arginine (about 5 per cent.) and a large proportion of monamido-acids (75-85 per cent., including at least three or four different acids).

Now the simplest protamines, of which salmin may be taken

as a typical representative, are found to be almost entirely converted by hydrolysis into two compounds: nearly 90 per cent. of their nitrogen, or 84 per cent. of their actual weight, is found as arginine (classes 1 and 2) and several per cent. of their nitrogen as monamidovaleric acid (class 3), the nature of the small remaining amount of product being as yet unknown. Basing himself on the qualitative simplicity of these products and the large preponderance of arginine, Kossel proposes, for the purpose of classification, to regard arginine, or rather the group from which it is derived, as the chemical nucleus of the albumin molecule, from which all the albumins may be derived by the addition of other groups. Increase in the complexity of the structure of the albuminous molecule is rendered evident by the appearance of a multiplicity of individual substances in classes 2, 3 and 4 of the products of hydrolysis. Thus sturin, a more complex protamine, yields only 58 per cent. of arginine, together with 25 per cent. of two diamido-acids (lysine and histidine, class 2), and a monamido-acid, the relations by weight showing that in this case four molecules of arginine are produced for one each of lysine and histidine.

A means of passing gradually from the chemical structure of these non-albuminous, ultimate products of hydrolysis back to that of the mother-substances, the albumins themselves, is afforded by the circumstance that the hydrolysis can be so effected, especially by means of the various proteolytic enzymes, that intermediate products, the albumoses and peptones, are formed. These, although certainly simpler in structure than the original albumins, still show the characteristics of the class, and it is the knowledge of their composition that must form the proximate object of research. For this purpose the intermediate products obtained from the protamines, which are known as the *protones*, afford the simplest material, and the results of these researches will be eagerly awaited.

A certain amount of progress has indeed already been made in the examination of the albumoses and peptones derived from the more complex albumins, for it has been shown that certain of the constituent groups of the original molecule are absent from some of the albumoses derived from it, whilst present in others, a proof that the molecule has been divided into dissimilar groups. This is true, for instance, of the tyrosine- and indole-forming groups of fibrin, which are present in protalbumose, but absent from heteroalbumose.

The highest degree of complexity among the albumins is exhibited by the glucoproteids and the nucleoproteids, of the decomposition products of which an illustration has already been given. These appear to be compounds of albumins with other—*prosthetic*—groups, such as the hexoses, hexosamines, purine derivatives, &c., and even inorganic groups like phosphoric acid.

In conclusion, it is pointed out that the old idea of albumin as a substance of fixed and definite properties must be abandoned; it must be recognised that the albumins form a group comprising many substances which differ greatly in structure and properties. In accordance with the general principle of evolution, the aim of the investigator must be to find a chemical system of albumins which, progressing from the simplest up to the most complex member, shall reveal to us the true nature of these mysterious substances.

SCOPE AND FUNCTIONS OF MUSEUMS.[1]

IT is my lot, as director of the Natural History Museum in London, to have my attention very closely directed to the question as to what a public museum should aim at, what should be its objects, and how it should be organised for effecting them. I am inclined to think that few people ever ask themselves why we have museums, how they came to exist, and why public funds are expended on them, both by municipalities and by the State.

The word "museum" is in itself a strange one, which has acquired a special and restricted meaning. In Germany a club for music and discussion of art and science, with the maintenance of a library, and sometimes with a beer garden attached, is often called a "museum," much as we call a club an Athenæum. In England and in France the word museum—by a process which I cannot trace—has within the past two centuries become applied to what used to be called a "cabinet of curiosities (or rarities) of art and nature." You will find that all our great museums, and many local museums, owe their origin to such cabinets or collections of rarities. Thus the British Museum originated with the collections of Sir Hans Sloane, and the Ashmolean and University Museums at Oxford had as their nucleus the collection of miscellaneous objects of interest formed by the Cornish antiquarian and naturalist Tradescant. These collections were always, in the first instance, of the most miscellaneous kind. An elephant's skull, a glove worn by Queen Elizabeth, a thunderbolt and a cannibal's spear are samples of the objects placed in these collections side by side. When such "cabinet" or "collection" of rarities attained to celebrity, its fortunate possessor (in the eighteenth century) made a habit of bequeathing it, or possibly selling it, to some public body, so that it might be maintained for ever as a show for the delight and instruction of future generations of men. That seems to be the origin of public museums, and it goes on repeating itself even at the present day. A collector gives his collections to a public body, to a city Corporation, or to the State, or to a local Board, or a Committee; the charge is accepted, and another "museum" is instituted.

Whilst it is certainly ungrateful to look a gift horse in the mouth, or to scrutinise too closely the collection bequeathed or presented by an enthusiast, yet it is a fact that this kind of spasmodic and unconsidered foundation of museums is inconvenient at the present day. We have now had some experience of museums, and a little reflection will show us what is the good and what is the bad of these miscellaneous collections, and what any public body should aim at when accepting or taking charge of a museum.

As distinguished from a library or a picture gallery, a museum, as we understand the term at the present day, is a repository in which are partly exhibited, partly stored, objects, tangible things, which are neither books nor pictures, but are actual relics of antiquity or samples of animal, vegetable or mineral structure of such a nature as to extend or to illustrate our knowledge of the history of man or of the natural world.

It seems to me—if I may go at once to the point without further preface—that a public museum, whether it be that belonging to a municipality such as ours here in Ipswich, or one belonging to the State, such as the British Museum, should have two distinct and recognised objects, the germ of which we can trace in the old collectors' cabinets of rarities of nature and of art. In the first place, such a museum must aim at collecting and preserving for the study and information of all men, but especially of those who live near it, the records of antiquity and of natural history in the locality of which it is the centre. A great part, even a half of the space of a museum building, should not be occupied by exhibition cases, but contain cabinets and cases in which precious things are preserved ready for the study of those who are willing to give time and skill to their study. But the second great object of a museum (present also in the old collectors' minds) is to exhibit in the most perfect and attractive way, in public show galleries, to all who choose to come and see, the most interesting, beautiful and instructive of the things in its possession, and especially to show such things as will readily excite an interest in the study of archæology and natural history amongst the inhabitants of the town or city in which the museum is situated.

There is a third use of museums, and the collections in them, which ought, I think, to be very carefully separated from the two I have just mentioned. A student of text-books, preparing for examination and carefully pursuing his educational studies, requires specimens to handle and to manipulate closely. A collection suited for his purposes is quite different from the exhibition-collection addressed to the larger public, and ought never to be confused with it or with the record-collection of a local museum. These strictly collegiate and technical collections ought to be placed in colleges and schools, and kept apart from the more striking and generally interesting collections. When the public is admitted to such students' collections a great mistake is made. The ordinary man is bewildered and wearied by such minute details as are fit for the academic student, and becomes so bored and exhausted that the word "museum" has ever after an evil sound in his ears. You cannot appeal artistically and effectively to the casual well-meaning visitor to a museum if you show him endless rows of obscure objects, which nevertheless have value for the special student. My opinion is very strong that these two kinds of

[1] Abridgment of an address delivered at the opening of a new wing of the Ipswich Museum on November 8, by Prof. E. Ray Lankester, F.R.S., president of the Museum.

collections should be kept far apart, and I doubt very much whether the State or the municipality should undertake to set out and exhibit students' collections. They inferere, in my judgment, with the two great combined objects of a "public museum," namely, first to preserve objects of permanent interest and value, especially those of the locality; and, secondly, to excite in the general public—the ratepayers who pay for the whole affair—a pleasurable and intelligent interest in the purposes of the museum by the exhibition of a limited number of fine specimens, not crowded together, but well set out and beautifully housed and cared for.

Nothing is so hostile to the true spirit and purpose of a public museum as to exhibit in it dirty, ill-mounted, mean and contemptible specimens. Next to this, nothing is so bad for a public museum as to crowd specimens in the cases, so that none produces its due effect. After this, in order of harmfulness, come illegible and careless labelling and bad classification. Local museums suffer from want of funds to pay for good cases and good setting out of specimens, and for the printing of good labels. Still more, perhaps, do they suffer for want of funds to pay for the intelligent services of a curator. But in regard to this, I believe that when there is a great deal of voluntary service and personal help given in a town, with the object of making the museum a worthy show of which the town can be proud, there need not be much difficulty in paying the salary of a curator. I must, however, tell you that he ought not to have other work to do, if you wish him to keep your museum in a state of efficiency and beauty.

Perhaps one of the greatest difficulties which local museums suffer from is the ill-considered generosity of local collectors. I know of several museums which are rendered more or less ridiculous by the worthless collections of ill-stuffed birds or other such objects, presented and, I regret to say, accepted by well-meaning committees or trustees. No collection should ever be accepted with conditions attached to it unless money is also given for carrying out those conditions, and, as a rule, no collection whatever should be accepted *en bloc* from a private donor. The friends or relatives of a deceased collector very often seem to think that a public museum is a place where rubbish may be shot. This should not be allowed. The managers of a museum, with the advice of their curator, should have definite purpose and intention, and should know what they want and try to obtain it by gift or purchase. But they should not allow themselves to be the instruments of vanity or sentiment, and should never allow their museum to become a receptacle for rubbish, no matter by whom it is offered.

If I might venture to apply some of these remarks to the Ipswich Museum, I should say the Museum ought first of all to provide an absolutely safe repository for objects of antiquity found in the neighbourhood, extending from flint implements and Roman pots to old china, brass-work and wood-carving; also for the skins of rare birds and mammals taken in Suffolk, and for the fossils of the wonderful Red Crag, which is unique as a geological phenomenon in England. Such things should be cared for, labelled, and preserved with the greatest care. The best of these things should be exhibited in the best possible cases, with ample space, and in your best rooms, fully labelled and explained. It forms *the* local collection. But besides these, and as illustrating them and the sciences with which they are connected, you should have as many really fine examples of birds and mammals, of fishes, shells, starfish and corals as your space and your funds allow you to show in a really beautiful and attractive way. These also should be fully labelled and explained. That is a *sine qua non*. They should comprise such things as the skeleton of the horse and the man, side by side; of the lion and the cat; and a few other perfect and well-chosen examples of the skeletons of animals. Then you should have the whole or parts of recent elephants to illustrate the Mastodon of the Crag and the Mammoth of the river-bed of the Orwell. The skeleton of the recent bull should be compared with the extinct ones whose bones are dug up in the local gravels. Then a glimpse should be given of some of the utterly strange extinct monsters whose skeletons are preserved in larger museums, from which you can obtain complete casts, scarcely distinguishable from the original specimens.

I do not think there is any advantage in setting out on perches in the glare of daylight, which soon destroys their colour, a complete set of British birds. If you have these and their eggs, they should, excepting a few of the more striking, be unmounted and kept in drawers.

In such a Museum as this, plants, of course, will not be neglected. A herbarium can readily be formed and kept for reference and record. But for your exhibition cases there are many most interesting features concerning the seedlings, early and later growth, and changes of our native trees, which form most striking and instructive exhibits. In an agricultural county a set of models illustrating the life-history of wheat, such as has lately been set up in the Natural History Museum, would be greatly appreciated. Further, let me say that there is a no more beautiful and interesting class of objects for a public museum than really fine crystals and minerals of various kinds. The history of agates, and of the carnelians and other pebbles from the Felixstowe beach would form a delightful and most attractive case in the Ipswich Museum. But in no instance should there be a mean or dirty or ill-considered specimen in any one of your glass cases.

I think that the whole of one of the larger rooms in such a museum should be kept shut up and used for placing cabinets and for storing those specimens in glass cases with which it is not desirable to try the patience of the general public. They should be accessible on proper application; but why show all your doubtful specimens, your obscure though important fragments, your faded skins of birds and mammals to the public? It is not always right to destroy unsightly specimens, but it is never right to offend and disappoint the innocent visitor to a museum by thrusting them under his eyes. He wishes to be pleased, to learn something—not too much—but still something of natural history. You may lead him on by judicious exhibition to enthusiasm and serious interest in science: then he will be able to tolerate the sight of your sick specimens, but you gain a bad reputation for museums if you let your visitor be disgusted at the very first by incongruity and neglect.

A county museum is not a place for children or school-teaching: it is not Noah's Ark or Madame Tussaud's waxworks, but a place for the delight of grown-up men and women. It should be full of the things which are the pride of those who care for the history and natural life of their countryside, and just as you do not use a picture gallery to teach the elements of drawing, but for the enjoyment of fine pictures, so your county museum must be for the enjoyment by your grown-up, educated people of the rarities of nature and of art, and not for the cramming of schoolboys and schoolgirls.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

OXFORD.—The curators of the University chest have been authorised to spend 1050*l*. in erecting a new chemical laboratory over some of the existing rooms.

Prof. E. B. Tylor delivered a public lecture on November 22 upon totems and totemism, with special reference to the magnificent totem-post from British Columbia which he has recently presented to the Pitt-Rivers Museum.

Brasenose College has elected the keeper of the Ashmolean Museum to an *ex-officio* fellowship, which will have the effect of increasing his stipend by 100*l*. a year and augmenting the income of the Ashmolean Museum and the University Galleries by the same sum.

The 229th meeting of the Junior Scientific Club was held on November 20; a paper was read by Dr. Collier on "Health and Athletics," and Mr. A. T. V. Sidgwick read a paper on "Acetone Di-propionic Acid."

MR. E. H. GRIFFITHS, F.R.S., Fellow of the Sidney Sussex College, Cambridge, has been appointed Principal of the University College of South Wales and Monmouthshire in succession to the late Mr. Viriamu Jones.

THE first number of the *London University Gazette* has appeared, and is largely taken up with a statement of the constitution of the reorganised University and the conditions under which the work is now being carried on. The text is given of an address sent to Prof. Virchow on his eightieth birthday, and of one to Yale University upon the occasion of the recent bicentennial celebrations.

A COMMENDABLE characteristic of the Calendar of University College, London, is the list of original papers contributed by members of the scientific departments of the College to various

societies and publications. The list contains nearly one hundred papers as the record of activity during the College year 1900–1901, and it is a better testimony to the work carried on than many successes at examinations. A similar statement of investigations made in the laboratories of the Royal College of Science and the Solar Physics Observatory during the session 1899–1900 will be found in the recently-published report of the Board of Education, vol. iii.

SCIENTIFIC SERIAL.

American Journal of Science, November.—On the effect of temperature and moisture on the emanation of phosphorus, and on a distinction in the behaviour of nuclei and of ions, by C. Barus.—On the determination of the heat of dissociation and combustion of acetylene, ethylene and methane, by W. G. Mixter. Acetylene was exploded alone and with oxygen and the amount of heat evolved measured. If acetylene is exploded without oxygen in presence of a small quantity of ethylene, the latter is completely decomposed, and in this way the heat of dissociation can be more accurately determined than by the usual combustion method.—The geological relations and the age of the St. Joseph and Potosi limestones of St. Francois County, Missouri, by F. S. Nason.—Note on the Cambrian fossils of the Francois County, Missouri, by C. E. Beecher. From the fossils found an extensive area and thickness of sedimentary rocks are definitely placed in the Cambrian. Palæontological evidence as to the nature of these rocks had hitherto been largely wanting.—Discovery of Eurypterid remains in the Cambrian of Missouri, by C. E. Beecher. Description and drawing of *Strabops Thacheri*.—The determination of persulphates, by C. A. Peters and S. E. Moody. An experimental examination of the methods proposed by Mondolpho, Namias, Le Blanc and Eckhardt, Grutzner and the author. The process of Le Blanc and Eckhardt, the oxidation of ammonio-ferrous sulphate in sulphuric acid solution, is recommended as being simple, rapid and convenient.—Studies of Eocene mammalia in the Marsh collection, Peabody Museum, by J. L. Wortman. A continuation of previous papers on the same subject.—The Carboniferous and Permian age of the red beds of Eastern Oklahoma from stratigraphic evidence, by G. I. Adam.

SOCIETIES AND ACADEMIES.

LONDON.

Physical Society, November 22.—Prof. S. P. Thompson, president, in the chair.—Prof. W. Cassie read a paper on multiple transmission fixed arm spectroscopes. The simplest form of spectroscope shown consisted of two half prisms silvered on the back, between which a beam of light goes backwards and forwards with a slight upward inclination. The result in dispersing and resolving power is equivalent to direct transmission through a long train of prisms. The collimator and observing telescope are fixed and adjustment is made by a double tangent screw which moves both the prisms. Two other types constructed on a similar principle were described, of which one had one prism and two speculum mirrors, and the other had two refracting prisms and a reflecting right-angled prism. The adjustments of these instruments are simple and their power great. By a small movement of an adjusting screw the observer can produce great changes of dispersion by passing from one to another of the series of spectra which are produced. The author in reply to questions said that with an ordinary Bunsen burner sodium flame a series of about five spectra is easily observed with dispersion equivalent to direct transmission through ten full-sized prisms. The loss of light at the reflections limits the number of transmissions that can be used; but he believed that no other spectroscope with only two prisms would give dispersing power and resolving power in any way approaching the instrument described.—Prof. W. Cassie then read a paper on the measurement of Young's modulus. The apparatus described consisted of a horizontal needle (a bar of large moment of inertia) supported by a bifilar suspension made of the wire of which the stretch modulus is to be measured. The periods of the pitching, rolling and bifilar oscillations of this system are observed, and an expression for the stretch modulus is obtained which involves no measurements except the weight of the needle and the periods of oscillations. The necessary adjustments, and the means of eliminating residual errors of adjustment, were described for two forms of the apparatus. One form also affords a simple means of statical measurement by hanging a small weight on the needle at measured distances from the centre, calculating the difference of tension produced in the wires, and observing with a mirror and scale the consequent dip of the needle.—A paper entitled "Notes on Gas-Thermometry, Part ii.," by Dr. P. Chappuis, was read by Dr. Harker. Messrs. Holborn and Day have published recently in a research on the air thermometer the results of a new determination of the expansion of Berlin porcelain between 0° and 1000°. The author has already drawn attention in a former note to the fact that part of the divergence found between the results of Callendar and Griffiths and of Harker and himself for the boiling-point of sulphur may be attributed to the uncertainty in the values assumed for the expansion of porcelain. In the present paper the author examines the way in which their results would be modified by the introduction of the dilatation deduced from the experiments of Messrs. Holborn and Day. It follows from the introduction of the new values that the boiling-point of sulphur deduced from experiments with a porcelain reservoir thermometer would be lowered from 445°·2 to 444°·7, a number very close to that obtained by Callendar and Griffiths. In a second part of the paper Dr. Chappuis has recalculated the divergences between the uncorrected nitrogen scale and the theoretical scale, and finds that the difference between these values and those given previously is too small to be of any practical importance. Prof. H. L. Callendar said that he was highly gratified to see that the application of the correction for the expansion of the bulb of Dr. Chappuis' gas-thermometer, deduced from Holborn and Day's results, gave a value, 444°·7, for the boiling-point of sulphur in such close agreement with the value 444°·5, deduced by Mr. Griffiths and himself in 1890. The agreement was really much closer than appeared at first sight, because the remaining difference of two-tenths of a degree in the results was almost exactly accounted for by the scale difference of the constant pressure and constant volume thermometers according to the theory of Joule and Thomson. It was also interesting to remark that the corrected result found by Dr. Chappuis was in very close agreement with that deduced from their own observations by Messrs. Holborn and Day. Dr. Chappuis had not referred in the present note to the work of Bedford on the expansion of Bayeux porcelain, which he had criticised in a previous paper. A comparison of results would show that Bedford's results agreed very fairly, allowing for the difference of material, with Holborn and Day's from 200° to 600° C.; and that both differed from those of Dr. Chappuis between 0° and 80°, when extrapolated, in a precisely similar manner. It was quite possible, as he (Prof. Callendar) had previously suggested, that the expansion of porcelain between 0° and 100° was anomalous. It appeared certain that some anomaly in the expansion at 800° was indicated both in the experiments of Bedford and also in those of Holborn and Day. It was also clear that Dr. Chappuis' results for Bayeux porcelain when extrapolated would agree with Bedford's at a temperature a little above 100° C., or very nearly at the same point at which his results for Berlin porcelain agreed with those of Holborn and Day.

Mathematical Society, November 14.—Dr. Hobson, F.R.S., president, in the chair.—After the ballot had been taken the president announced that the gentlemen whose names were published in NATURE (October 17) were duly elected for the current session. Dr. J. Larmor, F.R.S., propounded a query regarding the recent behaviour of Nova Persei which gave rise to remarks by the president, Dr. Glaisher, F.R.S., and Messrs. Hargreaves, Hough and Lieut.-Colonel Cunningham, R.E.—Prof. Love, F.R.S., communicated two papers by Mr. J. H. Michell, (1) on the inversion of plane stress, and (2) on the theory of Hele-Shaw's experiments on fluid motion, dwelling specially on the latter paper, which also evoked some discussion.—Mr. E. T. Whittaker read a paper on the solution of dynamical problems in terms of trigonometrical series. The president spoke at some length upon the subject and other members joined in a discussion.—The following papers were communicated by the reading of their titles:—Linear groups in an infinite field, Dr. L. E. Dickson; note on the algebraic properties of Pfaffians, Mr. J. Brill; on Burmann's theorem, Prof. A. C. Dixon; the Puiseux diagram and differential equations, Mr. R. W. H. T.

Hudson; determination of all the groups of order 168; Dr. G. A. Miller; an outline of a theory of divergent integrals, Mr. G. H. Hardy; limits of logical statements, Mr. H. MacColl; addition theorems for hyperelliptic integrals, Mr. A. L. Dixon; on the representation of a group of finite order as a permutation group, and on the composition of permutation groups, Prof. W. Burnside, F.R.S.; note on Clebsch's transformation of the equations of hydrodynamics, Mr. T. Stuart, and linear null systems of binary forms, Mr. J. H. Grace.

Geological Society, November 6.—Mr. J. J. H. Teall, V.P.R.S., president, in the chair.—Note on a submerged and glaciated rock-valley recently exposed to view in Caermarthenshire, by Mr. Thomas Codrington. This valley was brought to light in building a bridge across the River Towy at Drysllwyn, nine miles above Caermarthen, to which the tide now flows. At the bridge the valley is narrowed to about half a mile. Near the water edge the rock sloped down gradually to 23 feet below summer water-level, and was glaciated in large furrows a foot or more across, and striated blocks of grit rested upon it. About 60 feet farther out into the river rock was not met with till depths of from 34 to 42 feet below summer level were reached, and the rock-surface was found to be sloping towards the south at an angle of from 28° to 18° with a vertical line; it was followed down to between 45 and 56 feet below summer water-level. Scratched stones were again met with in the clay near the rock. The glaciated surface on the northern bank is only 25 feet above sea-level; and the rock-surface is sloping down at a precipitous angle at 8 feet below sea-level at a distance of eighteen miles from the mouth of the river.—On the Clarke collection of fossil plants from New South Wales, by Mr. Edward Alexander Newell Arber. This collection, numbering nearly 2600 specimens of all kinds, including some 80 fossil plant-remains, was presented to the Woodwardian Museum, Cambridge, in November 1844. Among other points discussed is the age of the beds. Such evidence as the few plants in the Clarke collection afford supports Feistmantel's conclusion that the Wianamatta beds are of Triassic age. *Thinnfeldia odontopteroides* occurs in Rhætic beds in South America, and the identification of Rattee's *Salisburia palmata* with the American *Baiera multifida*, and a comparison with the Rhætic *Baiera Steinmanni* of Chile, is a new point in favour of this conclusion. The plants also support Feistmantel's opinion that the Newcastle beds are equivalent to the Permian of Europe. The exact origin and age of the Arowa beds must for the present remain doubtful. In the discussion that followed Dr. Blanford expressed his satisfaction at hearing a paper read before the Geological Society in which the Palæozoic age of the Australian Coal-Measures was fully accepted on palæontological evidence. For many years the question had been debated between McCoy, backed by all the European palæontologists, Schimper among others, who declared that the Newcastle beds of Australia were Jurassic, on the one side; and on the other, by the geologists of New South Wales, among whom none did more valuable work in proving the Palæozoic age of the Coal-Measures than the Rev. W. B. Clarke, the collector of the specimens described by the author.—On an altered siliceous sinter from Builth (Brecknockshire), by Mr. Frank Rutley.

Zoological Society, November 19.—Mr. William Bateson, F.R.S., vice-president, in the chair.—Prof. E. Ray Lankester, F.R.S., read a memoir on the new African mammal, *Okapia johnstoni*. After an account of the history of the discovery of this remarkable animal by Sir Harry Johnston, Prof. Lankester gave a description of its skull and skin, based upon the specimens forwarded to the British Museum by the discoverer, and compared its structure with that of the giraffe and the extinct member of the same family, Helladotherium. The nearest living ally of the okapi was undoubtedly the giraffe.—Mr. Oldfield Thomas read a paper on the five-horned giraffe obtained by Sir Harry Johnston near Mount Elgon. It was shown that, although the horns were unusually developed, the animal could not be specifically separated from the ordinary North-African giraffe, *Giraffa camelopardalis*. This latter was believed to grade uniformly in the development of the horns and other characters into the South-African form, which would therefore be only a subspecies, *G. c. capensis*. On the other hand, de Winton's *G. c. reticulata* (from Somaliland) seemed to be sharply separated, and therefore to be worthy of recognition as a distinct species, *G. reticulata*. With regard to the accessory horns, it was shown that they, or rudiments of them, existed in all male giraffes, even in the southern subspecies. Mr. Thomas believed that these rudimentary horns corresponded, not only to the somewhat similar projections found in Samotherium and the okapi, but also to the large posterior horns of Bramotherium, and perhaps of Sivotherium. If this were the case, it seemed probable that they were the degenerate rudiments of horns which had been large and functional in the giraffe's ancestors.—Mr. J. Graham Kerr read some notes on the genito-urinary system in the male Lepidosiren and Protopterus, in which he gave an illustrated account of the more important anatomical features of the organs. Mr. Kerr dwelt particularly on the presence in both Lepidosiren and Protopterus of very definite remains of a testicular network, and pointed out that the presence in all three Dipnoi of the connection between the testis and the kidney gave greatly increased probability to the view that this connection is a very ancient and primitive feature of gnathostomatous vertebrates. Mr. Kerr also pointed out that the conditions in the Dipnoi shed considerable light upon the relations of testis and testis-duct in the Crossopterygians and the Teleosts.—A communication was read from Mr. Alfred E. Pease, M.P., containing some field-notes on the antelopes obtained during his expedition to Somaliland and Southern Abyssinia in 1900–1901.

Mineralogical Society, November 12.—Dr. Hugo Muller, F.R.S., president, in the chair.—Mr. R. H. Solly, in continuation of his investigations on minerals from the Binnenthal, described baumhauerite, a new sulph-arsenite of lead, $4PbS.3As_2S_3$, which crystallises in the oblique system ($\beta = 82° 42'\frac{3}{4}$); the crystallographic examination of good recently-acquired crystals of dufrenoysite led him to refer this mineral also to the oblique system with $\beta = 90° 33'\frac{1}{2}$; twin crystals of hyalophane from the Legenbach Binnenthal were also described.—Dr. H. Warth contributed a note on the occurrence of gibbsite in the Palni Hills in southern India.—Prof. H. A. Miers gave an account of a visit to the Klondike which he had made last August at the invitation of the Canadian Minister of the Interior. He described the various methods of mining which are in operation this year, and showed a number of photographs illustrating the great changes which have taken place in the mining camp. An account was given of the various conditions under which the gold occurs.

EDINBURGH.

Royal Society, November 4.—The Hon. Lord M'Laren in the chair.—The chairman read an opening statement describing the work done during the preceding session and enumerating the losses the Society had sustained, with special reference to the great loss occasioned by the death of Prof. Tait, who had for many years acted as general secretary.—A paper on variable stars of the Algol type was communicated by Dr. A. W. Roberts. It dealt with the star C.P.D. 41°·4511, whose period of variation of brightness is 1 day 20 hours 30 minutes. The light curve has one well-marked minimum lasting 4 hours 30 minutes, with a diminution 0·85 from the normal brightness, which is steady for the remainder of the period with the exception of a short drop of 0·1 dividing it into two symmetrical parts. These variations of brightness are due to the two stars which form the double system eclipsing one another wholly or partially as viewed by an observer on the earth. From them Dr. Roberts deduces the following elements for the double-star system:—Diameter of each (probably the same), 0·325, the distance between them being unity; inclination of orbit, 6° 43′; ratio of the brightnesses of the two components, 6 : 1; and mean density 0·44 of the sun's density, or about two-thirds that of water. The theoretical light curve calculated from these data agreed exactly with the observed light curve.—Prof. MacGregor read a note on the relation of the density of electrolytes to ionisation, chiefly with reference to certain discrepancies which appeared when the densities were measured and calculated to six significant figures.—Prof. Chrystal communicated a paper, by Mr. J. N. Miller, on an instrument for the mechanical trisection of an angle. A rod OAB is rotatable about the fixed point O; and a second rod PAX pivots on A, and PA is made equal to OA. From M, the middle point of AB, a perpendicular is constructed of convenient length. If O is placed at the vertex of the angle to be trisected, the trisection is accomplished by adjusting the instrument until the point P lies on one side of the angle and the other side of the angle passes through the intersection of AX with the perpendicular to the middle point of AB. The curve

on which the properties of the instrument depend is a unicursal curve of the sixth degree, and Prof. Chrystal showed how, by making a templet in the form of part of the curve, the trisection of a given angle could be easily effected with the use of a pair of compasses.

CAMBRIDGE.

Philosophical Society, November 11.—Mr. W. Bateson, vice-president, in the chair.—The unit of classification in systematic biology, by Mr. H. M. Bernard. The writer described the difficulties he had experienced in grouping the stony corals into genetic groups, and maintained that the time had come when for such unstable groups a new technique was urgently required. The present unit of classification, the only one we had at our disposal, was the species. Hence if these are not discoverable the work is brought to a standstill. His work with the stony corals had suggested to him a geographical method of designating the varying *forms* as the units for work. These forms he proposed to arrange in geographical lines. Upon the chart of each genus thus obtained he proposed to arrange the different structural variations exhibited within the genus, and hoped to find in this way a powerful and searching instrument for morphological study by means of which in time a natural classification may be built up.—An exhibition of fishes and amphibians to illustrate new methods of mounting specimens for museums, by Mr. J. S. Budgett.—Notes on the development of Sagitta, by Mr. L. Doncaster. The paper confirmed O. Hertwig's account of the development in most points, but showed that Bütschli's account of the formation of the head-cœlom was correct. Sections were described showing the temporary obliteration of the cœlom and the origin of the muscles. The genital cells were described, and the origin of the posterior septum between them during larval life. The development of the genital ducts was discussed, and this, together with the mode of origin of the transverse septa and absence of nephridia, led to the rejection of the view that the Chætognatha are connected with Annelids.

DUBLIN.

Royal Irish Academy, November 11.—Prof. R. Atkinson, president, in the chair.—Prof. Charles J. Joly read a paper on the interpretation of quaternions as point-symbols. The author explained a convention by means of which a quaternion may be interpreted as the symbol of a weighted point. He assumes an arbitrary origin, and writing

$$q=(1+\mathrm{OQ})\mathrm{S}q, \quad \mathrm{OQ}=\mathrm{V}q/\mathrm{S}q,$$

he interprets the quaternion q as denoting the point Q at the extremity of the vector $\mathrm{V}q/\mathrm{S}q$ drawn from the origin. The weight attributable to this point is $\mathrm{S}q$—the scalar part of the quaternion—so that multiplication by a scalar leaves the representative point unchanged and merely alters the weight. He gave some examples of applications to projective geometry, and pointed out that the equations

$$\mathrm{S}q(f+f^1)q=0, \quad \mathrm{S}q(f-f^1)p=0$$

represent respectively the equation of the general quadric surface and the equation of the general linear complex, f being a linear quaternion function and f^1 being its conjugate. The equations of the reciprocals of these loci are simply

$$\mathrm{S}q(f+f^1)^{-1}q=0, \quad \mathrm{S}q(f-f^1)^{-1}p=0.$$

The principle of duality presents itself with perfect naturalness, and a quaternion may also be regarded as the symbol of a plane. Thus two objections to the calculus of quaternions have been removed—the want of a point symbol and of a concrete interpretation for a quaternion—and, what is in the author's opinion of much greater importance, the whole field of projective geometry is rendered easily tractable by quaternion methods.—Prof. Joly also read a paper on quaternion arrays. In the previous paper the author employed and extended a most useful but neglected notation of Hamilton's ("Elements," art. 365 [6]) in order to define lines, planes and volumes in terms of two, three and four quaternions or points. In this paper the notation is further extended, and the vanishing of the array with quaternion constituents

$$\left\{\begin{matrix} a_1, & a_2, & a_3 & \ldots\ldots & a_n \\ b_1, & b_2, & b_3 & \ldots\ldots & b_n \\ \ldots & \ldots & \ldots & \ldots & \ldots \\ p_1, & p_2, & p_3 & \ldots\ldots & p_n \end{matrix}\right\} \quad (n \text{ columns, } m \text{ rows}),$$

expresses the possibility of determining n scalars $t_1, t_2, \ldots\ldots t_n$, so that

$$\Sigma t_1 a_1=0, \quad \Sigma t_1 b_1=0, \quad \ldots\ldots \quad \Sigma t_1 p_1=0.$$

The laws of expansion and of manipulation of these quaternion arrays are explained, and it is pointed out that the quotient of a two-row and a one-row array

$$\left\{\begin{matrix} fa, & fb, & fc, & fd \\ a, & b, & c, & d, \end{matrix}\right\} \div \{a, b, c, d\}$$

comprises all the Hamiltonian invariants of the linear quaternion function f—a result easily extended to the case of any number of functions by increasing the number of rows in the first array. As another example of the use of these arrays, if μ is the couple and λ the force of a wrench, the origin being base-point, the invariants of an n-system of screws are at once deducible from the array,

$$\left\{\begin{matrix} \mu_1, & \mu_2, & \mu_3 & \ldots\ldots & \mu_n \\ \lambda_1, & \lambda_2, & \lambda_3 & \ldots\ldots & \lambda_n \end{matrix}\right\}.$$

—Mr. Frederick Purser read a paper on the application of Bessel's functions in the theory of elasticity. This paper attempts to use Bessel's functions in the discussion of the elastic equilibrium of a right circular cylinder. It is shown that the elastic forces and displacements at any point when no bodily forces act can be expressed as the sum of two series, one of which proceeds by products of exponential functions of z and ordinary Besselians in r, the other by products of trigonometrical functions of z with Besselians in r of imaginary argument. The method is also applied to certain cases of applied bodily force, and various practical problems are considered both with a view to approximate solution and as illustrating the St. Vénant theory of equipollence, on which it is conceived the present method throws some light.

PARIS.

Academy of Sciences, Nov. 18.—M. Fouqué in the chair.—On the periods of double integrals in the theory of algebraic functions of two variables, by M. Émile Picard.—On a modification in the mode of use of an electrical thermometer, for the determination of subterranean temperatures at the Museum of Natural History, by M. Henri Becquerel. A description of a new method of applying the thermocouple to the determination of temperature at a distance. A d'Arsonval galvanometer, the deviations of which are proportional to the intensities of the currents, is used, and the scale of this galvanometer is calibrated in degress by direct comparison with the thermocouple and a mercury thermometer. One junction of the thermocouple is then placed in the point the temperature of which is required, and the other in mercury along with a thermometer. Since the deflection of the d'Arsonval is now proportional to the difference of these temperatures, the graduated scale is displaced parallel to itself in such a manner that the zero of the galvanometer coincides with the line indicating the temperature of the junction in the mercury. On closing the circuit the reading on the scale now indicates the temperature of the distant junction.—The study of ammonium amalgam, by M. Henri Moissan (see p. 89).—On the Perseids of 1901, by M. Perrotin. There has been an increase in the number of meteors from the Perseids during the present year. The observations at Nice were somewhat incomplete on account of the weather. On August 10 there was an average of 10 stars per hour, on the 11th, 25 to 30 per hour, on the 12th, 32 were counted during the 40 minutes observations were possible, and only 24 were seen on the two following nights.—Observations of the Perseids made at Athens, by M. D. Eginitis. These stars were seen on the four nights commencing on August 9, and were counted up to the sixth order. About 500 meteors were observed in all, the maximum display being on the 11th, when on the average 31 per hour were seen.—On a manometric differential log, by MM. Emile Raverot and Pierre Belly. The two sides of a manometer are connected to two tubes under the water in the same horizontal plane, one tube opening in the direction of motion of the vessel, the other being at right angles. In the case of the tube in the direction of motion, the pressure depends partly upon the velocity of the vessel and partly upon the variable static pressure due to its depth below the surface of the water. The latter effect is completely compensated by the second tube, and by the introduction of a suitable damping arrangement the readings of the manometer are a function of the speed of the vessel alone. The scale is graduated empirically by runs over a measured distance.—The law of radiation at low temperatures, by M. Compan. A series of experiments were carried out on the rate

of cooling of a blackened ball, the temperatures being measured by means of a thermocouple. The rate of cooling was taken over the ranges 302° to 0° C., 174°·3 to −79°·2 C. and 15° to −182°·5 C., and the experimental values compared with those calculated from the formulæ of Dulong and Petit, Stefan and Weber. The formula of Dulong and Petit was found to apply roughly only between 0° and 200°, that of Stefan covered the whole range from the boiling-point of liquid air to 302°, whilst the formula of Weber does not apply at low temperatures, but for the range 100° to 302° it has the advantage over Stefan's formula.—On the combinations of gold and chlorine, by M. Fernand Meyer. Gold was converted completely into the chloride $AuCl_3$ by the action of liquid chlorine in a sealed tube at 70° C. The dissociation of this pure chloride into AuCl and Cl_2 was then studied, and also the dissociation of AuCl into chlorine and gold. No indication was obtained of the existence of a chloride of gold intermediate between $AuCl_3$ and AuCl.—On dioxyisopropylhypophosphorous acid, by M. C. Marie. A study of one of the three acids obtained by the action of hypophosphorous acid upon acetone. The acid is monobasic, and from its analysis and the fact that it forms diacetyl and dibenzoyl derivatives it is assumed to have the constitution $[(CH_3)_2(OH).C]_2PO(OH)$.—The action of some acid chlorides upon the sodium derivatives of methyl and ethyl acetoacetates, by M. Bongert. Details of the compounds obtained by the action of propionyl chloride and butyryl chloride upon ethyl acetoacetate, and of isovaleryl chloride and caproyl chloride upon methyl acetoacetate.—The oxidation of unsaturated alcohols by contact action; the preparation of vanillin, by M. A. Trillat. The vapours of the alcohols mixed with air are submitted to the action of a hot platinum spiral. Allyl alcohol gave 5 per cent. of its weight of acrolein, cinnamic alcohol gave the corresponding aldehyde and isoeugenol gave vanillin. Eugenol gave the same product.—The spermatocyte divisions and chromosome special to the Orthoptera, by M. R. de Sinety.—The blue and green colorations in the skin of the vertebrates, by MM. Camichel and Mandoul. It has been known for some time that the blue coloration of the skin in certain vertebrates is not due to a blue but a black pigment; green skins contain two pigments, black and yellow. A study of these coloured skins with the spectrophotometer shows that there is a complete analogy between these and the phenomena exhibited by turbid media, the curves obtained from skin and from artificial turbid media such as lamp-black and Chinese ink being absolutely similar.—The relation between the liver, skin and hair from the point of view of the pigments and iron, by M. B. Floresco.—The influence of the ingestion of wine on the development of tuberculosis, by M. L. Roos. From experiments made with guinea-pigs the author concludes that there is no reason to suppose that the ingestion of alcohol in the form of wine accelerates the course of tuberculosis.—The formation of pearls and their "diseases," by M. S. Jourdain.—The measurement of the blood pressure in lunatics, by MM. Ed. Toulouse and N. Vaschide. It is shown that there is a distinct connection between the blood pressure and mental troubles; there is also a change in the blood pressure corresponding to different states of the same patient.—A mechanical theory of vision, by M. Antoine Pizon.—An anatomical comparison between grafting, the removal of the heads of buds and annular decortication, by M. L. Daniel.—On chlorophyll assimilation in autumn, by M. Jean Friedel.—On the mica schists, gneiss, amphibolites and green rocks of the schists of the western Alps, by M. Pierre Termier.

DIARY OF SOCIETIES.

THURSDAY, NOVEMBER 28.

ROYAL SOCIETY, at 4.30.—Micro-crystalline Structure of Platinum: T. Andrews, F.R.S.—A Comparative Study of the Spectra, Densities and Melting Points of some Groups of Elements, and of the Relation of Properties to Atomic Mass: H. Ramage.—On the Properties of the Arterial and Venous Walls: Prof. J. A. MacWilliam.—The Development of *Echinus esculentus*: Prof. E. W. MacBride.

INSTITUTION OF ELECTRICAL ENGINEERS, at 8.

MONDAY, DECEMBER 2.

SOCIETY OF ARTS, at 8.—The Chemistry of Confectioners' Materials and Processes: William Jago.

IMPERIAL INSTITUTE, at 8.30.—Planters and Planting in Tropical Greater Britain: R. Hedger Wallace.

SOCIETY OF CHEMICAL INDUSTRY, at 8.—The Lemon Oil Industry: Herbert E. Burgess and J. F. Child.—The Separation of Materials of Different Specific Gravity: J. W. Hinchley.

TUESDAY, DECEMBER 3.

ZOOLOGICAL SOCIETY, at 8.30.—On the Myriapoda collected during the "Skeat Expedition" to the Malay Peninsula, 1899–1900: F. G. Sinclair.—On the Crustacea collected during the "Skeat Expedition" to the Malay Peninsula, 1899–1900: W. F. Lanchester.—On the Anatomy and Systematic Position of Rhynchæa: F. E. Beddard, F.R.S.

INSTITUTION OF CIVIL ENGINEERS, at 8.—*Paper to be further discussed*: Train Resistance: J. A. F. Aspinall.

AERONAUTICAL SOCIETY, at 8.—Aërial Navigation by the Body heavier than Air: Sir Hiram Maxim.—Atmospheric Currents: William Marriott.—Navigable Balloons, and the Scientific Aspects of M. Santos Dumont's Experiments: Eric Stuart Bruce.

WEDNESDAY, DECEMBER 4.

SOCIETY OF ARTS, at 8.—The Identification of Wood and its Application to Scientific and Commercial Purposes: Herbert Stone.

GEOLOGICAL SOCIETY, at 8.—On a New Genus belonging to the Leperditidæ, from the Cambrian Shales of Malvern: Prof. T. T. Groom.—The Sequence of the Cambrian and Associated Beds of the Malvern Hills: Prof. T. T. Groom, with an Appendix by C. A. Matley.

ENTOMOLOGICAL SOCIETY, at 8.

SOCIETY OF PUBLIC ANALYSTS, at 8.

THURSDAY, DECEMBER 5.

ROYAL SOCIETY, at 4.30.

SOCIETY OF ARTS, at 4.30.—The New Trade Route to Persia by Nushk and Seistan: Edward Penton.

LINNEAN SOCIETY, at 8.—On the Foraminifera collected round the Funafuti Atoll from Shallow and Moderately Deep Water, with Notes on New Species from the Sands of the Reef Slope: F. Chapman.—Protoplasmic Connections in the Lichens: Dr. J. H. Salter.—Exhibition: Ten Abnormal Sacra of the Frog: Dr. A. G. Ridewood.

CHEMICAL SOCIETY, at 8.—Influence of Substitution on the Formation of Diazoamines and amino-azo-compounds: G. T. Morgan.—The Determination of Available Plant Food in Soils by the Use of Dilute Solvents: A. D. Hall and E. J. Plymen.—Some New Derivatives of Gallic Acid: E. B. Power and E. Shedden.

FRIDAY, DECEMBER 6.

GEOLOGISTS' ASSOCIATION, at 8.—Notes on a Recent Visit to Egypt: Dr. C. W. Andrews.

INSTITUTION OF CIVIL ENGINEERS, at 8.—Gas-Engine Construction: R. W. A. Brewer.

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THURSDAY, DECEMBER 5, 1901.

PASTEUR.

The Life of Pasteur. By René Vallery-Radot. Translated from the French by Mrs. R. L. Devonshire. Pp. 628; 2 vols. (Westminster: Archibald Constable and Co., Ltd., 1902.) Price 32*s*.

"L'ŒUVRE de Pasteur est admirable; elle montre son génie, mais il faut avoir vécu dans son intimité pour connaître toute la bonté de son cœur," wrote one of Pasteur's most distinguished disciples who was in daily intercourse with him.

This sentiment, so simply and so eloquently expressed by Dr. Roux, can now, thanks to M. Vallery-Radot, be shared by that larger circle of Pasteur's friends and admirers who, distributed in all quarters of the globe, knew him in his public capacity, but could not have the privilege of being included amongst his intimate associates.

There are, however, few men whose scientific writings reflect the inner life of the man to the same extent as do those of Pasteur, for with Pasteur his work was his life—his religion, and it was inseparably bound up with every action, with every aspiration.

M. Vallery-Radot has enabled us to accompany Pasteur throughout his career, to share alike in his joys and his sorrows, in his anxieties and triumphs, guiding and directing us the while with consummate skill, so that the true proportion of the actions and events which are recorded is maintained in their relation to the whole. As Pasteur's son-in-law, M. Radot has had exceptional opportunities for undertaking this biography, and already we are familiar with his workmanship in that vivid sketch of Pasteur published many years ago, in which the authorship is modestly veiled under the title "l'histoire d'un savant par un ignorant." This little volume was brought out in Pasteur's life-time; since his death we have had M. Duclaux's intellectual appreciation of his master, whom he succeeded as Director of the Pasteur Institute, Dr. Roux's sympathetic personal reminiscences of his great teacher, M. Fleury's impressionist sketch, and in England the volume in the Century Science Series, for which the writer of this notice and her husband are responsible. M. Radot's work differs from all of these inasmuch as he has had access to letters and diaries, note-books and divers documents which were to others inaccessible, and by the judicious use of which the personal element is so happily brought into relief and yet blended so harmoniously with its surroundings.

Of no man could it be more truly said that whatsoever his hand found to do he did it with all his might; the *de minimis non curat* did not exist for Pasteur. As Dean of the new Faculté des Sciences at Lille, for example, despite his passionate devotion to his researches on crystals and molecular dissymmetry, he would forsake his beloved laboratory to take his students round factories and foundries, even organising a tour in Belgium so that they might visit the industries of the country, "questioning the foreman with his insatiable curiosity, pleased to induce in his students a desire to learn."

Later, when he returns to the École Normale as administrator and director of scientific studies, in which office was included such miscellaneous duties as the surveillance of the economic and hygienic management, the responsibility for general discipline, intercourse with the families of the pupils and the literary or scientific establishments frequented by them, we find him noting down as matters for attention "Catering; ascertain what weight of meat per pupil is given at the École Polytechnique. Courtyard to be strewn with sand. Ventilation of class room. Dining hall door to be repaired."

If professors in this country have in the past had but slight encouragement to embark upon research, what would they have said to the position of Pasteur in this respect, who at the École Normale, in addition to such vexatious demands upon his valuable time, had no laboratory, but a garret only in which to carry on his investigations, whilst we hear of him later "building a drying-stove under the staircase; though he could only reach the stove by crawling on his knees, this being better even than his old attic"?

The general state of affairs connected with higher education in France was indeed at that time most deplorable, and Duruy, the enlightened Minister of Public Instruction, whilst sympathising with the lamentable position occupied by science in the country and deeply regretting the penurious policy which stifled its aspirations, was unable to make his voice heard in Cabinet councils, the other ministers, we are told by him, "being absorbed in politics."

Pasteur and Duruy had often discussed the contrast presented by the flourishing young University of Bonn, with its staff of fifty-three professors and vast laboratories for chemistry, physics and medicine, and the Strassburg faculty, with its handful of teachers, hampered in every direction by a policy of deplorable penury. It is not surprising to find Pasteur, in the anguish of his soul, well-nigh crushed by the disasters which overwhelmed his country, bitterly exclaiming in 1870:

"We savants were indeed right when we deplored the poverty of the department of Public Instruction! The real cause of our misfortune lies there. It is not with impunity—as it will one day be recognised, too late—that a great nation is allowed to lose its intellectual standard. . . . We are paying the penalty of fifty years' forgetfulness of science, of its conditions of development, of its immense influence on the destiny of a great people, and of all that might have assisted the diffusion of light."

Again he writes in a pamphlet entitled "Why France found no Superior Men in the Hours of Peril":—

"France has done nothing to keep up, to propagate and to develop the progress of science in our country. . . . She has lived on her past, thinking herself great by the scientific discoveries to which she owed her material prosperity, but not perceiving that she was imprudently allowing the sources of those discoveries to become dry . . . Whilst Germany was multiplying her universities, establishing between them the most salutary emulation, bestowing honours and consideration on the masters and doctors, creating vast laboratories amply supplied with the most perfect instruments, France, enervated by revolutions, ever vainly seeking for the best form of Government, was giving but careless attention to her establishments for higher education."

This crying need of a people was voiced by Pasteur more than thirty years ago, at a time when great national disasters were sweeping all before them; a quarter of a century later these words sound a prophetic note of warning to another nation which, with similar arrogance and similar criminal neglect, has made a fetish of political illusions whilst the very foundations upon which the soul of the people depends have been forgotten or deliberately ignored.

"Is it not deplorable, almost scandalous," exclaims the Minister Duruy, "that the official world should be so indifferent on questions of science?" Would that England had a minister who, whilst sharing such a conviction, possessed the courage to express it! Pasteur with rare prescience was never weary of insisting upon the importance of higher education; "if that teaching is but for a small number, it is with this small number, this *élite*, that the prosperity, glory and supremacy of a nation rest," and we find him again and again returning to the same theme.

M. Radot takes us step by step along the victorious path which Pasteur cleared in the conquest of the most difficult scientific problems of the day. Yet he reminds us that those imaginative people

"who would decorate the early years of Louis Pasteur with wonderful legends would be disappointed; . . . at the Arbois College he belonged merely to the category of good average pupils . . . at the examination for the *baccalauréat ès sciences* he was only put down as *médiocre* in chemistry."

But all this was to be changed, and under the inspiring influence of two such teachers as Balard and Dumas he became a student of chemistry second to none in the enthusiasm for his subject.

His discoveries in crystallography soon won for him a foremost place in the scientific world. In a letter from the great physicist Biot to Pasteur's father we have a charming tribute paid by the aged to the young philosopher.

"It is the greatest pleasure that I can experience in my old age to see young men of talent working industriously, and trying to progress in a scientific career by means of steady and persevering labour and not by wretched intriguing. That is what has made your son dear to me, and his affection for me adds yet to his other claims and increases that which I feel for him."

Biot's friendship for Pasteur, which ripened into a fatherly love and pride in his work, only terminated with his death and was one of Pasteur's most valued possessions.

It will be remembered how Mitscherlich had discovered that the two tartaric acids so familiar to chemists, while apparently identical in chemical composition, in chemical properties, in crystalline form and, in fact, in every known detail, behaved differently in solution towards polarised light. This distinguished crystallographer, unable to detect any difference in these two tartrates, asserted that they were identical in every other particular. Pasteur could not accept this conclusion as to the absolute identity of these substances in face of the fact of their different behaviour towards polarised light, and determined, if possible, to procure some of the inactive tartaric or racemic acid and submit it to an exhaustive examination. But how to procure this racemic acid? Originally obtained in 1820 by Kestner, at Thaun, through a mere accident in the manufacture of tartaric acid, it had suddenly ceased to appear in spite of all efforts to obtain it again. Pasteur's emotion was immense on hearing from Mitscherlich that a manufacturer in Saxony had again produced some racemic acid, and that he believed the tartars employed had originally come from Trieste. "I shall go to Trieste," says Pasteur, in a fever of excitement; "I shall go to the end of the world. I *must* discover the source of racemic acid, I must follow up the tartars to their origin."

Armed with letters of introduction, he starts off on his voyage of discovery and, writes a contemporary, "never was treasure sought, never adored beauty pursued over hill and vale with greater ardour."

How he succeeded in obtaining specimens and in establishing a minute difference in the crystalline structure of these two acids, overlooked by the renowned and experienced Mitscherlich, and how his fundamental discovery of the relationship which exists between crystalline form and optical activity, followed up by a series of masterly investigations, has given birth to that fertile offshoot of chemical science known as stereochemistry, is familiar to all.

The red ribbon of the Legion of Honour was his country's recognition of these brilliant discoveries in the field of chemical science. In the further prosecution of his investigations, Pasteur discovered that if he allowed one of the salts of racemic acid to ferment, the dextro-tartaric component was alone acted upon, which action in his own words he declares to be "the ferments of that fermentation feeding more easily on the right than the left molecules." At this time, when his attention was being arrested by the problems of fermentation in connection with the production of chemical compounds, he was appointed professor at Lille. Difficulties encountered by a local manufacturer in the production of beetroot alcohol induced Pasteur to turn his thoughts more especially to the phenomena of fermentation, and these studies led by a natural sequence to his throwing down the gauntlet to the great Liebig and entering single-handed upon that famous contest with the most brilliant intellects of the day as to the origin of the phenomena of putrefaction and decay.

The current contempt for Pasteur's conclusions may be realised from the following words emanating from the most distinguished chemist of the day. In 1845 Liebig wrote:—

"As to the opinion which explains putrefaction of animal substances by the presence of microscopic animalculæ, it may be compared to that of a child who would explain the rapidity of the Rhine current by attributing it to the violent movement of the numerous mill-wheels of Mayence."

Pasteur relates how, several years later, he visited Liebig in his laboratory, anxious to induce him to acknowledge the truth of his theories; he was received with kindly courtesy, but on endeavouring to approach the delicate subject he had so much at heart, Liebig, "without losing his amenity, refused all discussion, alleging indisposition."

The multiplicity and varied character of Pasteur's researches have been well-nigh forgotten by a generation which almost exclusively associates his name with the

work of his later years—rabies and its prevention. His researches on vinegar, on the diseases of wine, his laborious investigations extending over years which succeeded in disclosing the origin of the diseases in silkworms which had threatened to ruin the silk industry of France, his studies on beer, collected in a magnificent volume covering nearly 400 octavo pages, are but a few of the colossal labours which occupied his mind before he became absorbed in the study of contagious diseases.

At the ripe age of fifty-five we find him devoting himself with all the energy and enthusiasm of youth to the study of pathological phenomena. Various theories as to the origin of anthrax were in the air at the time when Pasteur determined to enter the field. M. Radot gives a most vivid account of these researches and of the hopes and anxieties to which Pasteur was a prey at this time, living as he did in a condition of intense nervous tension and excitement during their progress. Difficulties, however, never deterred, they only served to stimulate, Pasteur. The memoir in which Pasteur and his assistants communicated their successful investigations on anthrax and septicæmia to the Academy of Sciences is famous, not only on account of the manner in which they mastered the etiology of these diseases, but also for the extreme fertility and originality of the ideas and experiments which it records. Having established the identity of the virus he set to work to discover a means of combating its action, and thus he was led to those epoch-making researches in the domain of immunity which were to succeed in converting a virus into a vaccine—a malignant foe into a beneficent friend—and which have made the name of Pasteur a household word revered in the remotest corners of the globe.

M. Radot, besides giving us a faithful and fascinating history of Pasteur's scientific life and aspirations, has with the delicate touch of a master revealed the inner life of this great genius, with rare subtlety indicating the essential character of the man who,

"absorbed as he was in his daily task, yet carried within himself a constant aspiration towards the ideal, a deep conviction of the reality of the infinite and a trustful acquiescence in the mystery of the universe."

No one who reads Pasteur's speeches can fail to be struck by the lofty tone which pervades them; he sought always the highest and scorned to touch what was base; his deep religious sense communicated itself to all who were brought in contact with him, from the most exalted in the land to the poorest student who came to work under his guidance.

In one of those public utterances which in his declining years became so rare and so eagerly sought for he tells us:

"Our only consolation, as we feel our own strength failing us, is the consciousness that we may help those who come after us to do more and to do better than ourselves, fixing their eyes as they can on the great horizons of which we only had a glimpse."

This is the keynote to his life, embodying the same passionate desire to help others which stimulated him from his earliest years, but mellowed by the ripeness of advancing age, and the consciousness of a life fast drawing to a close, the burden of which was soon to be laid aside.

G. C. FRANKLAND.

A MANUAL OF MEDICINE.

A Manual of Medicine. Edited by W. H. Allchin, M.D., F.R.C.P. Lond., F.R.S. Edin., Senior Physician and Lecturer on Clinical Medicine, Westminster Hospital. Vol. iii. *Diseases of the Nervous System.* Pp. x + 417. (London: Macmillan and Co., Ltd., 1901.) Price 7*s.* 6*d.* net.

THE third volume of Dr. Allchin's "Manual of Medicine" is well up to the standard of its predecessors, in fact, if anything, may be regarded as rather exceeding it. Here, in 417 short pages, the student of medicine has at his command a complete and up-to-date book upon that ever-increasing domain of medicine, nervous disease. The difficulty of editing must in this volume almost have reached its maximum. When we come to consider the enormous mass of literature which has accumulated since even the publication of the last standard book upon this subject, we may perhaps appreciate the great difficulty of compressing our compendious knowledge upon nervous disease into what may, without forcing language, be called a manual. In these circumstances we can hardly expect theories to be discussed *in extenso*, or ample polemic justice to be done to controversial matter. The book is filled with terse fact, and if its readability suffers somewhat on this account, its value to the student is proportionally increased.

With the space at our command we must content ourselves with indicating rather than describing the contents of the book. Even to those out of touch with the burning problems of nervous disease, and only generally interested with the physiology of the nervous system as a part of biology, it will be manifest that the recent progress in histological method, the product of increased knowledge of bio-chemistry, has profoundly modified our conceptions of the constitution of the nervous system and also neuro-pathology.

In an introductory chapter Prof. Sherrington deals with the physiology of the nervous system in a most lucid and wonderfully succinct manner. This chapter is followed by one contributed by Dr. Aldren Turner upon the general pathology of the nervous system. Dr. Turner points out that the adoption of the conception that the nervous system consists of a series of neurons necessarily precludes us from continuing to divide affections of the nervous system above the foramen magnum from those below. The only true system of classification must be one based upon the neuronic systems primarily involved. It must, however, be admitted that a given morbid process need not necessarily confine itself to one neuronic system, but may simultaneously implicate two or more. Several other articles are contributed by the same author. The one on focal diagnosis is especially to be recommended.

With the beer-poisoning epidemic fresh in our memory we naturally turn to the article on peripheral neuritis, which is written by Dr. Purves Stewart. The different varieties of neuritis are well described, the author wisely abstaining from controversial matter. Dr. Ormerod contributes articles upon the spinal cord and its membranes and the muscular dystrophies.

The volume concludes with a most instructive and

beautifully illustrated article on medical ophthalmology, by Dr. James Taylor, and one on the medical applications of Electricity, by Dr. Bertram Abrahams.

Dr. Allchin's third volume is, in our opinion, highly to be recommended. We know of no book in the language upon this subject which will be more worth the student's, and indeed the practitioner's, while to read and to possess.

F. W. T.

PRACTICAL MATHEMATICS.

Practical Mathematics for Beginners. By Frank Castle, M.I.M.E. Pp. ix + 313. (London: Macmillan and Co., Ltd., 1901.) Price 2*s*. 6*d*.

THIS little book deserves the title of Practical Mathematics better than any work that we have seen. The subjects dealt with are arithmetic, plane geometry, algebra, mensuration and analytic geometry. The chapters on arithmetic deal with those operations in which this subject is most nearly related to algebra—such as the theory of fractions, ratio and the extraction of the square root. The part on geometry is strictly limited to constructions with rule, compass, &c., and explains the use of simple and diagonal scales; it is in no sense a course of deductive geometry such as we have in the books of Euclid. The part of the book dealing with algebra is more extensive, but still very elementary; it does not, for example, include a discussion of quadratic equations, although it shows how a quadratic expression in x can, in very simple cases, be resolved into factors. While noticing this part of the book we may point out some corrections which should be made in the next edition. Thus, in p. 76, where it is proposed to resolve $x^2 - 9x + 20$ into factors, we find the statement, "Hence $x = 4$, or $x - 4 = 0$ is a factor." The beginner should be put on his guard against such a loose mode of expression. In the next example on the same page we find, "Next put $x = +5$, and it is found to be a factor." The factor referred to is $x - 5$. In p. 77 we have the incorrect expression, "When required to add, subtract or compare fractional expressions, it is necessary that they shall all have a common denominator." In p. 88, g is described as 32·2 "feet per second" instead of 32·2 "feet per second per second," which the majority of mathematicians have at last been forced to acknowledge as the only correct mode of speaking.

These, however, are minor blemishes which are very easily removed.

It is a cardinal aim with the author to make all his examples illustrative of questions relating to various branches of physics, and for a certain class of students (those who have already come into contact with such practical matters) this is a very good plan, because it enlists the interest of the learner in convincing him that he is applying his mathematics to something real. It is doubtful if the plan has as much value for the ordinary schoolboy who is, under our precious system of education, a complete stranger to everything in the domain of physics. Hence such questions as that in example 5, p. 88, relating to the arrangement of a number of Grove's cells, will not convey much meaning to any but students of physics. There are useful little chapters on logarithms, showing their use and illustrating several things in which beginners are very apt to make mistakes. After this we come to an explanation of the slide rule and its applications; and the remainder of the book is that which most entitles it to the name of Practical Mathematics, this portion being of value to the student who wishes to be able to apply his pure mathematics to the representation of physical results. Here there is a great deal of graphic work done by means of squared paper, and a considerable portion of the analytic geometry of right lines, circles and higher curves is expounded, the accompanying illustrations being all drawn from physics. The fundamental notions of the differential calculus are very well and simply explained by this same system of plotting on squared paper; and the ease with which the processes can be followed and understood even by beginners who have nothing but a knowledge of arithmetic and elementary algebra to go upon shows that, in our ordinary course of mathematical teaching, the differential calculus is very unnecessarily postponed—that, in other words, our mathematical course for beginners should be made eclectic in character, a portion of any subject being introduced when the mind of the student is in a state to understand it. Our present system is essentially different; we feel constrained to finish each subject before beginning another, although the finish of one subject may be much more difficult than the preliminary portion of that which is postponed; and we thus lose sight of the fact that our present divisions of mathematics are only artificial, and that mathematics is, in reality, one connected whole.

In the part of the work dealing with mensuration two planimeters are described—the Hatchet and Amsler's.

The work gives an excellent epitome of the various branches of mathematics dealt with, and it will serve as a store of very good exercises in elementary methods for all students who desire to make a practical use of their mathematical knowledge in picturing the relations between various physical quantities.

OUR BOOK SHELF.

Memorial Lectures delivered before the Chemical Society, 1893–1900. Pp. 560. With fourteen portraits. (London: Gurney and Jackson, 1901.) Price 7*s*. 6*d*..

THE Chemical Society has done an important service to chemists and to students of chemistry by collecting these memorial lectures into one volume, and issuing it under conditions which render it accessible to readers of whom some may not be Fellows of the Society and consequently have not enjoyed the advantage of hearing the lectures when delivered or of reading them in the pages of the *Transactions*.

The lives of the men whose work and achievements are commemorated in this volume link us with the now long-distant past, and remind us of the immense strides which have been made in consequence of their discoveries and the discoveries of their contemporaries since the days when Berzelius and, later, Liebig were the dominant authorities. They remind us of the great and almost sudden advance which was accomplished between 1850 and 1865, when the modern system of atomic weights, definite ideas of valency and constitutional formulæ were finally established. The student who aspires to understand by what methods and with what laborious effort the greatest degree of scientific accuracy is alone attainable must read about the work of Stas on atomic

weights. If he wants to know how physical ideas of the constitution of matter and the nature of electrical charges are applied to chemical problems he will read Fitzgerald's lecture on Helmholtz. If he looks for the story of Pasteur's wonderful scientific career and how the chemist applied his chemical experience to the difficult problems of disease and life he will find it admirably told by Frankland in this volume. There are fifteen of these essays in the book, and each possesses an individuality of its own and in general a very high standard of literary quality is reached.

It must, of course, be admitted that the volume does not give the whole history of the progress of chemistry during the last half century, for of course these lectures relate only to deceased *foreign* members of the Chemical Society. The work of Williamson, Odling, Frankland sen., Perkin, Gladstone and Crookes, for example, is only incidentally referred to, for happily these Fathers of Modern Chemistry, with one exception, are still with us. Neither does the volume include any account of the life-long labours of Berthelot, the senior Foreign Fellow of the Society, whose celebration of the fiftieth year of his scientific activity has so recently attracted the sympathetic attention of the whole civilised world. But the rising generation of scientific men may well be reminded in the words which M. Berthelot is reported to have spoken recently in the presence of the President of the French Republic at the Sorbonne, that it is not they who are making the science of the time, but their scientific ancestors. "If each of us adds something to the common domain in the field of science, of art, of morality, it is because a long series of generations have lived, worked, thought and suffered before us."

Experimentelle entomologische Studien vom physikalisch-chemischen Standpunktaus. Von Prof. P. Bachmetjew. Mit einem Vorwort von Prof. Dr. August Weismann in Freiburg i. Br. Erster Band. Temperaturverhältnisse bei Insekten. Pp. x + 160, mit 7 Figuren im Text. (Leipzig: Wilhelm Engelmann.) Price 4*s.* net.

HITHERTO the best-known researches into the temperature of insects have been those directed to the effects produced on the development or coloration of perfect insects reared from larvæ or pupæ which had been subjected to carefully graduated variations of high or low temperatures. There is, however, a very considerable literature, chiefly scattered in foreign periodicals, dealing with the temperature of insects from a much wider standpoint, especially as to their power of resistance to heat or cold. In the present work Prof. Bachmetjew, who commenced his researches in 1898, and who has already published some preliminary papers, has brought together and classified these scattered materials, adding to them the results of his own work.

The first section is devoted to the effects of temperature, moisture, movement, food, &c.; and the second to the extreme limits of heat or cold which insects are capable of resisting in their various stages. The bibliography at the end of the volume comprises, with additions, upwards of 200 references. The importance of this little volume of 160 pages is far greater than its unpretentious appearance would indicate, more especially as a very useful basis for further investigations and experiments. It is freely illustrated with diagrams and tables, and is too technical for a very detailed notice. The second volume, now in preparation, will be devoted to "Einfluss der äusseren Faktoren auf Insekten."

Flora of Guernsey and the Lesser Channel Islands. By Ernest David Marquand. Pp. viii + 501. (London: Dulau and Co., 1901.) Price 10*s.* 6*d.* net.

THE author of this work is to be congratulated on the way in which he has succeeded in his task of bringing up to date the state of our knowledge of a very interesting group of islands. The number of plants recorded in this volume for Guernsey and the lesser islands collectively is as follows:—

Flowering plants	828	species
Ferns and fern allies	29	,,
Mosses	156	,,
Hepaticæ	41	,,
Fungi	624	,,
Lichens	334	,,
Algæ	641	,,
Total	2653	species

The flowering plants and ferns are arranged and named in accordance with the last (eighth) edition of Babington's "Manual of British Botany." Each island is separately dealt with, and separate indexes are given for Guernsey, Alderney and Sark—the other five islands, viz. Herm, Jethou, Lihou, Crevichon and Burhou, not requiring one. For Burhou, indeed, less than a score flowering plants and ferns are recorded.

From the descriptive notes we learn that Guernsey is the most densely populated island on the face of the earth—a fact which the visitor, rambling through its country lanes, would find hard to realise. During the last twenty years the fruit-growing industry—owing largely to the extremely favourable climate—has advanced enormously. "At the present day there are certainly scores, if not hundreds, *of miles* of greenhouses in the island. . . . Every week-day during the spring and summer months large shiploads of vegetable produce leave Guernsey for the English markets, as many as 28,000 baskets and crates having been dispatched in a single day." Owing to draining operations and increased cultivation generally some of the rarer local plants will, before long, certainly disappear.

The first record for each plant is given, and interesting notes on its native names and former and present uses, &c. On p. 156 we find a blunder—one, however, repeated in every local flora, and indeed in many much more pretentious works which we have consulted—the plant there noted by Mr. Marquand is certainly not *Lycium barbarum*, but doubtless *L. chinense*. This last is a very different plant from the true *L. barbarum*, which is a thorny small-leaved desert plant—a native of North Africa—which is not anywhere naturalised in Britain or the British Islands. *L. chinense*, on the other hand, is a Chinese plant which readily naturalises itself.

G. N.

Water and Water Supplies. By J. C. Thresh, M.D., D.Sc. Medical Officer of Health to the Essex County Council. Third edition, revised and enlarged. Pp. xv + 527. (London: Redman, Limited, 1901.) Price 7*s.* 6*d.* net.

THIS work deals with the chemical composition and physical characters of water; the various sources from which it may be collected; the different ways in which it may be polluted and the effect on health of such pollution; the interpretation of the results of chemical analyses of water; the methods of purification and softening of water; the quantity required for domestic and other purposes; the protection of water supplies; the means of storage and distribution; and the law on water supplies.

Thus it will be seen that the subject is considered from every point of view of importance to those who are interested in providing a good water supply for domestic or trade purposes, and that the work appeals to a wide clientèle, to whom we have no hesitation in confidently recommending it.

For general accuracy, clear exposition and arrangement of subject-matter, and for evidence of a wide practical experience on the part of the writer, this work deserves to take a prominent place in public health literature. The book is well printed and tastefully bound.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

Automatic Actions.

IN the interesting paper on "Reflex Action" by Dr. W. Benthall, published in your issue of September 5, he speaks of acquiring some feat of manual dexterity in which, with practice, the required muscular action becomes automatic. It seems to me that the same rule applies to many operations which are generally regarded as purely mental, such as in the use of the first four rules in arithmetic, in writing grammatically and spelling correctly, and in speaking any language. If you think, the action becomes laborious and in all cases the result is uncertain. In the case of spelling this seems to occur to every one, so that if you have to look up one word in a dictionary, which shows that you have begun to think about spelling, you have immediately to look up a number of others. Many people who are employed as clerks, &c., no doubt in adding a column of figures have their minds completely blank without their knowing it. In my own case, both at school and afterwards, I was very slow at this process and very uncertain of the results if the figures were numerous, as in a money column, but I found out, more than twenty years after I left school, that by thinking, not of the figures, but of nothing, the process was easy and rapid and the results correct. In speaking, say, French, if a person has to think of grammatical rules, the gender of nouns, &c., he can never speak fluently; to do so he must think of what he intends to convey and let the words take care of themselves.

Lower down Dr. Benthall quotes Dr. Lewis Robinson, who says: "The horse roamed in a wild state, over plains of more or less long grass and low bushes. When a horse is alarmed he throws up his head to get as wide a view as possible. The cow, on the other hand, keeps her head low, as if to peer under the boughs which covered the marshy grass of her jungle home." Cases of terror are only occasional occurrences amongst domesticated animals, but in the wild state the necessity of caution in the first movements on awakening from sleep, for fear of attack by some lurking foe, is evident. Now when a horse rises he gets on his fore feet and lifts his head high, whilst the cow rises on her hind legs first and keeps her head low. The horse being naturally a timid animal and rather unweildy in the process of getting on his legs has learned to sleep mostly standing and so be ready to move off at once, or kick as required; hence a stableman always speaks to a horse before approaching him from behind to make sure that he is awake and so unlikely to kick. WILL. A. DIXON.

Sydney, October 14.

Does Man use his Arms in Locomotion?

THE letter by Mr. Martin under this heading in your issue of November 28 raises the two interesting questions, (1) whether the swinging of the arms in walking and running serves any useful purpose as an aid to progression, and (2) whether this movement is a vestige, as Mr. Martin suggests, of the progression on all-fours of man's ancestors.

The following considerations may be of interest, though they are probably not put forward for the first time.

The movement of the legs in opposite directions in different planes involves a reaction, in the form of a couple, upon the trunk, tending to rotate it alternately in opposite directions about a vertical axis. That such a rotation does take place normally, when the arms are at rest, can be seen if the latter are folded upon the breast over a long light horizontal rod to serve as an indicator. This is very obvious when running. Now the swinging of the arms, each in unison with the leg of the other side, introduces an opposing couple which more or less completely balances, about a vertical axis, the reciprocating motion of the legs. The importance of the efficient "balancing" of the reciprocating and revolving parts of a railway locomotive, if steady and economical running is to be obtained, is well known.

That children and even adults, when compelled to crawl upon all-fours, naturally and unconsciously adopt the movements of the limbs common with four-legged animals is generally considered an indication that man has retained the instinct for this mode of progression, though the conditions for its adoption may seldom occur. It seems reasonable to suppose that the swinging of the arms in walking and running is a modification of this instinct for a modified purpose. C. O. BARTRUM.

17, Denning Road, Hampstead, N.W., November 30.

Folklore about Stonehenge.

I HAVE been waiting for more able pens than mine to corroborate Rev. Osmond Fisher's letter on the *culhes lapidum* in a recent issue of NATURE.

The same tradition about a loaf being placed on each stone to facilitate counting occurs in other places where sarsens have been objects of reverence in bygone ages. In April, 1895, Mr. Albany F. Major (hon. sec. Viking Club) and myself went on a visit to Kits Coity House above Aylesford, Kent. At the foot of Blue Bell Hill on the way to Kits Coity there are a number of sarsens in a field. On inquiring of a rustic as to their whereabouts, in directing us to them he informed us that a baker had made a bet he would count them and placed a loaf upon each stone in order to count them correctly. This is a slight variant of Mr. Fisher's statement about Stonehenge, but the underlying idea is the same. R. ASHINGTON BULLEN.

The Vicarage, Pyrford, Woking.

PRESERVATIVES AND COLOURING MATTERS IN FOOD.

THE report of the Departmental Committee upon this subject was issued last week and will be assuredly welcomed by all interested both in the public health and also in the trades concerned. The work of the Committee has been noticed at length in the lay Press and we think, speaking generally, has given satisfaction. Here we shall refer more particularly to the scientific aspects of the report. The Committee was practically a committee of experts, and we venture to think this precedent might be followed more frequently in the appointment of committees upon kindred subjects; trade interests are safe in the hands of impartial experts, and the exclusion of the trade from a committee of the kind saves time and, we think, also tends to the attainment of a most important desideratum, viz. unanimity.

For some time past there has been a large and apparently influential party of alarmists with regard to the use of preservatives. These have all been heard at length by the Committee which has just reported. Their evidence consisted for the most part of elaborate *a priori* argument, in support of which the most profound erudition was occasionally produced; but, as the report politely says, the opinion expressed was not always based directly upon fact. In fact, if an inquirer turns the 500 pages of the Blue-book over in search of unequivocal instances of injury to health from preservatives or, indeed, colouring matters in food he will be lucky if he finds a single one. There is no doubt some difficulty in fastening definite injury upon so subtle a cause, especially since heretofore the presence of preservatives has not even been declared. Yet, nevertheless, for the last two years practically the whole medical profession has been well alive to preservatives in food being a possible source of injury to health, and yet no definitely ascertained case, or practically none, has been forthcoming. Upon such data it is obvious that the prohibition of preservatives *en masse* was out of the question, and the recommendations of the Committee practically resolve themselves into the regulation and control rather than the prohibition of preservatives. There are, however, two exceptions to this; formaline or formic aldehyde is prohibited altogether, and all preservatives and colouring matters are prohibited in milk. The decision with regard to formic aldehyde might strike the casual observer in that nowhere in the report is it directly stated that this substance in the quantities necessary is injurious to health; a peculiar difficulty, however, arises with regard to it, viz., the practical impossibility of quantitative control. It is obvious that a substance of such

potency in unlimited quantity could not be sanctioned in food. The other exception, milk, is obviously also upon a different level; the fact that it forms the staple diet of invalids and children renders it especially important that it should be as pure as possible. It was, further, quite apparent from the evidence that the milk supply of London could be adequately maintained without preservatives, and, further, that these substances tended to mask uncleanly dairying. For the prohibition of colouring matter in milk there seems less reason. Annatto is admittedly harmless, and if the recommendations of the Milk Standardising Committee be adopted the fat standard will be uniform, and hence the colour will no longer be, at any rate in this regard, deceptive. Anything which improves the appearance of food, without it is harmful or done with direct intent to defraud in the physiological sense, that is to mask an actual nutritive deficiency, should be encouraged in that by pleasing the senses we can often help the digestion and, further, often save actual waste, as people will not eat what does not look nice.

This brings us to one point upon which, apparently, the Committee do not agree, viz., the use of copper sulphate for rendering preserved vegetables and fruits permanently green. Three members of the Committee recommend the prohibition of this practice, but Prof. Tunnicliffe is of the opinion that the amount of copper should be restricted to half a grain per pound and declared. The difference seems to be one of general principle *versus* specific fact. The Committee regard the addition of a substance to food which in certain quantities is undoubtedly poisonous to be undesirable in any quantity. It appears, however, that it is very questionable whether the copper compound actually present in the green peas is poisonous. Prof. Tunnicliffe's experiments show clearly that only a relatively small moiety of the copper is absorbed, or at any rate remains in the human system, when it is ingested in the form in which it occurs in preserved peas. These results are practically identical with those obtained by Brandl in the German Gesundheitsamt. People have taken peas greened with copper for almost half a century and no case of chronic or acute copper poisoning has so far been traced to this cause. We cannot agree that evidence of the injurious effect of copper would be difficult to obtain; copper chemically is one of the easiest substances to detect, and physiologically it produces well-marked and fairly characteristic symptoms. Had copper poisoning from coppered peas occurred, we think it would not have escaped detection. It is at any rate to be hoped that we shall not be consigned everlastingly to brown peas without further investigation.

Some surprise may perhaps be felt that salicylic acid was not prohibited, as this substance is undoubtedly possessed of active medicinal properties; it is, however, stringently controlled, only one grain per pound or per pint being allowed. This substance is a very active antiseptic, and is especially useful in jam making and temperance beverages. The complete sterilisation of jam is very apt to break up delicate fruits which it is certainly a pleasure to have whole. Many experiments have been made with salicylic acid, and in the quantities recommended by the Committee it seems quite harmless.

The appendices to the report will be full of interest to the expert; they comprise reports on very complete physiological experiments handed in by Prof. Tunnicliffe, being his own work in collaboration with Dr. Rosenheim and others, also reports of visits to Ireland and Denmark and many other invaluable reference data.

The work of the Committee must certainly be designated as thorough in the extreme, and their recommendations as eminently sensible. In particular we consider the suggestion as an excellent one that machinery should be provided either by the Local Government Board or by the formation of a separate Board of Reference for exercising control over the use of preservatives and colouring matters in food. It is sincerely to be hoped that legislation on the lines of the report will not be delayed; the necessity for it is urgent, as anyone can see who follows the conflicting decisions given in the law courts under the present Sale of Food and Drugs Act.

PRZEWALSKI'S HORSE AT WOBURN ABBEY.

A PERIOD of twenty years has elapsed since Poliakoff described an apparently new species of wild horse obtained by the late Colonel Przewalski in the deserts of Mongolia, under the name of *Equus przewalskii*. Although only a single example was then obtained, much interest attached to the discovery, as the animal appeared from the description to be in several respects intermediate between the domesticated horse and the wild asses, or, at any rate, the Asiatic representatives of the latter. For a long period nothing more was heard of the animal, and zoologists were uncertain whether they had to do with a real species or a hybrid, or possibly with one of the feral or wild representatives of the common horse. Within the last few years, however, other specimens—some alive—were received in Russia, and one skin was sent to the Paris Museum. Although no very detailed or well-illustrated description of them has hitherto appeared, these specimens appeared to demonstrate that Przewalski's horse was entitled to rank as a distinct species.

Still, without making a visit to Paris or Moscow, English naturalists had no opportunity of satisfying themselves by actual inspection as to the distinctness of this interesting animal, and the figures hitherto published left several important features in obscurity. The acquisition by the Duke of Bedford of a drove of twelve fine colts (imported by Mr. C. Hagenbeck, of Hamburg) has brought this unsatisfactory state of affairs to a close, and it is now possible to study the characters of the species (in an immature state) with some approach to exactness.

The colts at Woburn Abbey, which were foaled last spring or summer, are about the size of Shetland ponies; and, if we may judge by the absence of "legginess" in their build, do not seem likely to grow very large. In general appearance they are much more like ponys than donkeys, the ears being short and the tails haired to within a comparatively short distance of the root, although there appears to be a certain amount of individual variation in this respect. Eleven out of the twelve have, however, white muzzles, which communicate to the head a somewhat asinine appearance. All are in their winter (or ? first) coats, which are of a dun colour, with the front of the legs dark brown or black, the mane and tail being also black. The mane is at present upright, but exhibits a slight tendency to fall over, which may increase with age; and there does not seem, at least in most cases, to be a distinct forelock. Most of the colts show no dorsal stripe, although in one or two there is a short one on the rump. There is no trace of a shoulder-stripe, or of dark barrings on the legs. Both fore and hind legs have callosities. So far as I can recollect, the underparts are lighter than the back. In young animals the true form of the hoofs is not fully developed, but I think the hoofs of these colts are of the relatively large size characteristic of the horse and the Asiatic wild ass.

The Woburn colts render it quite certain that *Equus przewalskii* is a true species and not a hybrid. It is equally clear that it is perfectly distinct from the kiang and all other races of the Asiatic wild ass.

The only other animal with which Przewalski's horse could be identical is the tarpan, or wild (or feral) horse of the Kirghiz steppe, which, as I am informed, is now extinct. Tarpan are, however, described by Pallas as

having a distinct dorsal stripe on the otherwise dun back, and a well-developed forelock, while the muzzle, with the exception of the nose[1] (which is whitish), is said to be black, and the tail, which appears to be haired to the root, is rather short and bushy in winter. Moreover, the colour of the tail and mane is said to be reddish-brown. Nothing is stated with regard to the front of the legs being black.

So far as can be determined from this description, the tarpan appears identical with *Equus caballus* (of which it is probably the ancestral form), which is certainly not the case with *E. przewalskii.*

But another important point arises in connection with the animal under consideration. Naturalists commonly divide the existing species of Equus into two groups, the one containing only the horse, and the other the asses and zebras. Przewalski's horse will, however, clearly find a place in the former group, and as this animal approximates in some respects to the kiang, which differs from the African wild asses by its shorter ears, larger hoofs (especially the front pair) and absence of a shoulder-stripe and bars on the legs, I am inclined to think that the horse, Przewalski's horse, and the kiang (Asiatic wild ass) form one natural group, and the African wild ass, quagga and zebras a second. This arrangement will harmonise with distribution much better than the old one.

Taking the tarpan as the wild representative of the horse, it will be noticed that all three members of the first group agree in the general absence of the shoulder-stripe and of dark markings on the legs. And the question then arises, how is it that certain domesticated horses (especially dun-coloured ponies in the Punjab) show both these markings? Can it be owing to a cross with the African ass, or is it due to reversion to the common ancestor of the equine genus? R. L.

TYCHO BRAHE'S OBSERVATORY.

IT was mentioned in a recent article on the tercentenary of Tycho Brahe's death (p. 6) that an account of excavations made in the island of Hveen has been published by Prof. Charlier, of Lund.[2] As Tycho's observatory has thus again attracted attention, it may not be out of place to give a short description of it as it was three hundred years ago, and of the very few remains of it now brought to light.

Tycho's magnificent buildings were destroyed less than twenty-two years after his death. In 1623 a mason was paid for 60,000 bricks "which he had pulled down and renovated from the old castle," and they were used to build a new dwelling-house at a little distance, which in its turn has disappeared within the last hundred years. Apparently the peasants of the island helped themselves to bricks and stones as much as they liked, as part of the foundation-stone (laid by Tycho's friend the French envoy, Charles de Danzay) was recently discovered in the wall of an outhouse of a farm on the east coast of the island, still showing part of the Latin inscription and the date 1576 August 8. When Picard was sent over by the Paris Academy, in 1671, to determine the geographical position of Uraniborg, only the foundations of the house and the greater part of the ramparts surrounding it were still intact, while on the site of the observatory only a slight hollow in the ground was noticeable. Picard did not trouble himself about making excavations, and apparently everything was left undisturbed until 1823, when the clergyman of the island, Ekdahl, made careful excavations. At Uraniborg he found the deep well which was under Tycho's kitchen and still supplies the neighbourhood with excellent water, while parts of the foundation-walls and some slight remains of the laboratory (in the basement of the house) were also unearthed. These must have been covered over again, as nothing was visible on this spot until the present year, when the same trifling ruins of Tycho's beautiful residence were again laid bare; but as nothing of any scientific interest was found, we may at once pass to the underground observatory, of which much more distinct traces still remain.

Uraniborg, the stately residence of Tycho Brahe, was finished in 1580 and contained four observing rooms, two at the north and two at the south end of the building. But already a year or two later a large meridian quadrant was erected in one of the sitting-rooms, and very soon, as the work increased, it was found that even with this addition to the equipment more instruments were wanted. In 1584 an observatory was therefore built on a low hill about a hundred feet south of the south corner of the enclosure of Uraniborg and slightly to the east. This observatory, of which we here give a view from the west and a plan,[1] was called Stellæburgum (Danish, Stjerneborg); in it the instruments were placed in three subterranean rooms (C, G and F on the plan), of which only the roofs rose above the ground, so that they were well protected from the wind. The entrance was to the north, and in the centre was a study, lighted by four small windows just above the ground, and which could be heated by a stove in a recess (at P), while off it there was an alcove with a bed where Tycho could rest during cloudy intervals. In 1585 two other rooms for instruments (D and E) were added, but the floors of these were almost on the level of the ground, probably because he had found it inconvenient not to be able to observe stars near the horizon from the three underground rooms. The whole was surrounded by a low wooden paling, forming a square with sides 57 feet long, with semicircular bends at the middle of each side of 20 feet diameter, and stone piers were placed inside the

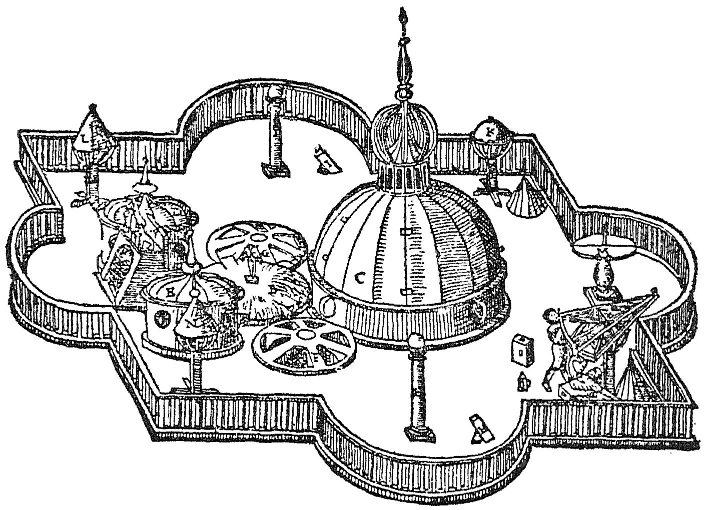

FIG. 1.—Stjerneborg Observatory, seen from the west.

[1] The expression "nose" is a little ambiguous, but the figures do not show a white muzzle like that of *E. przewalskii.*

[2] "Utgräfningarna af Tycho Brahe's observatorier på ön Hven sommaren 1901." Beskrifna af C. V. L. Charlier. 20 pp., 4to, with 3 plates. (Lund, 1901.)

[1] Taken from the writer's book, "Tycho Brahe," by permission of Messrs. A. and C. Black.

enclosure, on which portable instruments could be used when necessary.

In the centre of each crypt was a large instrument, the floor rising gradually by circular stone steps (shown on the plan) up to the walls. The floor of the crypt G was, however, flat; in it was placed a sextant of $5\frac{1}{2}$ feet radius for measuring angular distances in any plane. In the southern crypt (C) there was a large equatorial instrument, consisting of a declination circle of $9\frac{1}{2}$ feet diameter, revolving round a diameter parallel to the earth's axis, and having a semicircle of 12 feet diameter, supported on stone piers and representing the northern half of the equator. In the crypt F stood a quadrant of 7 feet radius, enclosed in a square and with an azimuth circle on the wall, in D another quadrant somewhat smaller and in E a zodiacal armilla like those used by the ancients. Of these instruments those in C and F were the most important, and an immense deal of valuable work was done with them.

Of this observatory and of the instruments in it very full and well-illustrated descriptions were published by

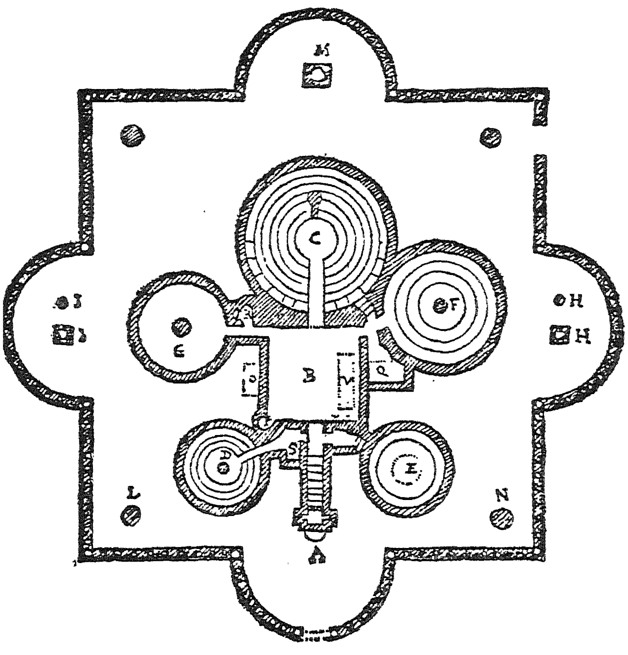

FIG. 2.—Plan of Stjerneborg:—A, entrance; B, study; C, crypt with largest armillæ; D, crypt with quadrant: E, crypt with zodiacal armillæ; F, crypt with largest quadrant; G, crypt with sextant; H, I, stone piers for portable armillæ; K, L, N, T stands for sextants; M, stone table; O, Tycho's bed; P, stove; V, table: Q, bedroom for assistants; S, unfinished underground passage towards Uraniborg.

Tycho. When he left Denmark he took all his instruments with him except the four largest, two of which were those in the crypts C and F, and the large equatorial was actually used by an assistant to observe the partial eclipse of the sun of February 25 (March 7), 1598.[1] They were, however, subsequently dismounted and sent to Bohemia, where every single instrument from Hveen was destroyed during the thirty years' war, except Tycho's large star-globe, which found its way back to Denmark only to perish in a great fire in 1728.

When Ekdahl, as already mentioned, examined the site of Stjerneborg in 1823–24, he found without difficulty the floors of the central study and of all the crypts more or less well preserved, one of them (F) being almost perfect, with the four circular steps and the short stone pillar in the middle on which the quadrant had been fixed. In the course of years everything became again covered with earth and grass except the crypt F, which was always visible, though generally more or less full of water. It furnished a valuable clue to the unit of linear measure employed by Tycho, as d'Arrest, in 1868, found the diameter of the crypt to be $11\frac{1}{3}$ Paris feet, which must be equal to the diameter of the azimuth circle of the quadrant which Tycho states to have been nine cubits. This gives one cubit = 16·1 English inches = 40·9 centimetres. Tycho, however, also makes use of feet, and d'Arrest found to his surprise, on measuring the length of the ramparts round Uraniborg, that the whole place was much smaller than the figures given by Tycho had led him to expect, the enclosure being only 233 French feet square instead of 300. The discrepancy was, however, easily cleared up, as Picard had carefully measured the great star globe in 1671, which gave one Tychonic foot = 0·815 English = 24·9 centimetres. These figures are of importance, as it is of interest to know the exact dimensions of the instruments, by means of which so great a revolution in practical astronomy was carried out. For instance, the radius of the great quadrant (in F) was five cubits long; one minute of arc was, therefore, 0·6 millimetre in length, and as Tycho says that he could by his transversal divisions distinguish 10″, this means that he could read off the arc to a tenth of a millimetre. In reality the accuracy attained was hardly as great, the probable error of one measure of altitude being certainly more than half a minute. But even this was a wonderful advance on what had been possible before Tycho's time, when errors of three or four minutes were unavoidable.

During the past year the site of the observatory has again been thoroughly excavated under the supervision of the Swedish inspector of antiquities and Prof. Charlier, of Lund. From the account published by the latter it appears that the tiled floor of the central study is almost perfectly preserved; it is 4 metres long (from north to south) by $3\frac{1}{2}$ metres broad. The floor of the alcove where Tycho's bed stood is also visible, the dimensions being only 185 by 125 cm. As it seems to have been completely underground, this tiny and grave-like bedroom can hardly have been a healthy place of rest, and it is to be hoped that the energetic observer did not use it very often. The floor of the study was found to be two metres below the ground. As Prof. Charlier's account is in Swedish, it may not be useless to give here a summary of the results of his examination of the five crypts. Of D, G and C the floors are left, all on the same level as the floor of B, and in D also the short pillar to which the lower end of the vertical axis of the quadrant was attached. The polished stone floor of E was 125 cm. above that of the study B and the steps leading up to it from the little vestibule north of the study are still intact. But the crypt F is almost in perfect preservation, with its four steps, the floor being 122 cm. below that of the study (or 10 feet below the ground), the inner diameter of the lowest step being 88 cm. and the outer diameter of the top step 345 cm. The top step was exactly on a level with the floor of the study. As the diameter of the top step was of importance for fixing the length of Tycho's cubit, it was measured again by a second observer, who found 354 cm. The mean of the two measures gives 1 cubit = 38·8 cm., agreeing sufficiently well with the 40·9 found by d'Arrest. Prof. Charlier found the value of a Tychonic foot from measures of the length of the foundation-wall of Uraniborg equal to 23·8 cm.; but as Tycho only says that the side of the square was "circiter pedes 60," this result can hardly be as accurate as that deduced from Picard's measure of the star-globe, as it seems likely that the latter was exactly 6 Tychonic feet in diameter, which Picard found equal to $55\frac{1}{12}$ French inches.

[1] See *Monthly Notices* R.A.S., vol. liv. p. 439.

The account of the recent excavations of Tycho's observatory thus forms a valuable supplement to the description published by Tycho himself. The idea of seeking shelter from the wind, by erecting his large instruments a couple of feet below the level of the ground, was a good one, and on the small island the force of the wind was doubtless not a negligeable quantity, particularly as the observatory was situated almost at the highest point of the island, about 160 feet above the sea, which is visible in all directions except in the south-east. Picard remarked that except where some hills in Scania rise to an altitude of 11′, he had often seen the stars down to the very horizon, which he considered very surprising, as this was never possible at the Paris Observatory, although the latter was about 120 feet higher than the level of Tycho's observatory. But the example thus set by Tycho was not followed; for more than a hundred years the object seemed generally to be to get as near to the stars as possible by placing observatories on the top of towers and high buildings—and in the midst of crowded cities. The nineteenth century has reverted to Tycho Brahe's ideas by building observatories at some distance from cities and with the instruments at very moderate heights above the ground. Another idea of Tycho's, which was not adopted for several centuries, was to have a large staff of assistants, among whom the work of the observatory was divided. He had cherished the hope for many years that the institution founded by him would be made a permanent one and not come to an end with his own life. Unfortunately he did not succeed in getting this settled in the lifetime of his benefactor, King Frederic II., and when he finally found that not only was it hopeless to expect a permanent endowment, but that even some of the valuable grants he had enjoyed for years were taken from him, he resolved to try if some other monarch would carry out his favourite idea and found a public observatory on a large scale. But Tycho had been very many years in his grave before this was done anywhere.

J. L. E. DREYER.

TECHNICAL SCHOOLS FOR RURAL DISTRICTS.

ENCOURAGED by the success which has attended the work of her sister, the Countess of Warwick, at Bigods, near Dunmow, in Essex, the Duchess of Sutherland has boldly entered upon a scheme for providing a technical school in a still more remote rural district, viz. near Golspie, on their Dunrobin estate in Sutherlandshire. No provision for secondary and technical education in the Scotch Highlands at present exists, and the proposed school must meet a long-felt want. The draft scheme which has been drawn up by the Duchess with the cooperation of Prof. Meldola provides for the education of fifty pupils in the principles of those sciences which bear in any way upon the local industries, including agriculture. The pupils will be taken from the elementary schools and admitted only when fully qualified to take advantage of the secondary training offered by the Sutherland school. In view of the excellent character of the elementary teaching in the Scotch schools, there should be no difficulty in finding a constant supply of promising pupils, the more especially as the new school is intended for board and residence and caters for the four counties of Sutherland, Ross, Cromarty and Caithness. Like Bigods, the Sutherland technical school is to be mixed and the curriculum adapted to the requirements of boys and girls. As stated in the scheme:—

"It is impossible that education in the Highlands should continue on the present lines. There is practically no technical training whatever. The old form of 'classical' education is still persisted in, and often a whole school suffers for the sake of three or four clever pupils who win the bursaries which send them to the University, from whence they issue as clerks, doctors or ministers as the case may be. The others are left to drift into idleness or to go away south to add to the population of our already over-crowded cities. The overcrowding of the fisher class is undisputed, and the dearth of skilled masons, carpenters and artisans, or competent hand-workers in the north, apart from the homespun tweed industry, is remarkable. There have been many peripatetic technical classes carried on under the County Councils and School Boards in the north, but this is the first technical school of the kind that has been started in the Highlands. It should be the pioneer of much educational reform, and it is started with a great belief in its ultimate possibilities."

The scheme has been considered by many educationists and has been approved of by Lord Balfour of Burleigh, Mr. Struthers, of the Scotch Board of Education, Sir Swire Smith, Mr. James Baker, Prof. Magnus Maclean and others. Practical appreciation of her Grace's efforts in the cause of education has also been shown by the substantial support which the scheme has already received. The Duke of Sutherland has given the site for the building and land for the agricultural work close to Golspie, besides 5000*l.* towards the building and equipment fund. Mr. Andrew Carnegie contributes 5000*l.* to the same fund and Mrs. Carnegie two bursaries of 30*l.* each annually. The Duke and Duchess of Sutherland, the Dukes of Westminster and Portland, and Mr. James Coates, of Paisley, also contribute annual bursaries. The work thus commences under very good auspices and is worthy of the most cordial support by all who are interested in the welfare of Scotland. At the present time, when "official" educators are, as was said recently, whistling for the wind of popular opinion, the country may well be proud of the splendid examples set by the Countess of Warwick in Essex and by her sister in the Highlands of Scotland. As pioneers in the introduction of scientific education into rural districts the names of these ladies will be written large in the annals of our educational development.

A PERIODICAL FOR STATISTICAL BIOLOGISTS.[1]

THE receipt of the first part of the new periodical, *Biometrika*, calls for more than mere formal acknowledgment. The methods of investigating biological problems statistically may be looked upon as having their origin in this country, and the names of the editorial staff are those of the pioneers in this modern departure—Francis Galton, and Profs. W. F. R. Weldon and Karl Pearson, associated with Prof. C. B. Davenport, of the University of Chicago. The part received is prefaced by an editorial article setting forth the scope and defining the spirit of the publication and an article on biometry from the pen of Mr. Galton. An admirable figure of the Darwin statue in the University Museum at Oxford, reproduced from a photograph by Mrs. E. B. Poulton, forms an appropriate frontispiece, the motto "*Ignoramus, in hoc signo laboremus*," being printed below the illustration. The papers contributed to this first part are seven in number, including those already mentioned. Prof. Dr. F. Ludwig writes (in German) on problems and materials for variation statistics; Mr. A. O. Powys con-

[1] *Biometrika.* A Journal for the Statistical Study of Biological Problems. (Cambridge: University Press. New York: The Macmillan Company.) Price 10*s.*

tributes data for the problem of evolution in man, anthropometric data from Australia; Miss Beeton and Prof. Pearson furnish a paper on the inheritance of the duration of life and the intensity of natural selection in man; Mr. E. T. Browne writes on variation in *Aurelia aurita*, and Prof. Weldon on a first study of natural selection in *Clausilia laminata*.

This first list of contributions augurs well for the future of an undertaking which deserves support from all workers in science who are interested in the theory of organic evolution in its broadest applications. The points of contact between mathematicians and biologists have hitherto been but few, and the time is yet remote when we may look for the advent of a skilled mathematician who shall also be an expert biologist, or *vice versâ*. But although the modern biologist may be unable to follow the mathematical processes of the new method, he will assuredly be impressed with the importance of the results, and such a work as that which has now been launched will serve as a common meeting ground for both classes of workers. The recognised methods of studying living organisms from the points of view of systemy and taxonomy, embryology, histology and anatomy, bionomics and distribution have all contributed to the sum total of that great division of natural knowledge which is known by the comprehensive title of biology. Side by side with these we must now place the newer statistical methods inaugurated with such marked success by Galton. This latest claimant to recognition as a legitimate weapon of scientific attack may be looked at with suspicion by those who are accustomed only to the older methods. We may remind our readers, however, that the value of measurement and statistical treatment was fully realised by Darwin, as made clear in one of the editorial articles in the present part of *Biometrika*. We may point out also that Wallace in his "Darwinism" (1889) fully recognised the value of such methods, and made considerable use of the measurements of lizards by Milne-Edwards and of birds by Mr. J. A. Allen for his discussion of the question of individual variability as furnishing the material for the operation of natural selection. Such data were imperfect compared with the modern requirements of statistical methods, but so far as they went they have been of service to the cause of Darwinian evolution, and this fact, again, tells strongly in justification of the appearance of a new periodical devoted entirely to this phase of biology.

There is no real antagonism—as some men of science have supposed to exist—between the older methods and the latest statistical methods. They are, or should be, on the contrary, mutually helpful. If by the measurement of large numbers of individuals and the mathematical treatment of such data the trend of evolution in any species can be detected, here at once is a suggestion for the observing naturalist to work upon—to endeavour to find out the nature and cause of the survival in a certain direction; in other words, to hunt down the selecting agent. Where ordinary observation has in so many cases failed, the newer methods appear to open out endless possibilities of attacking such problems. The student of bionomics will, as statistical data and their deductions accumulate, have definite information given as to what is going on in particular species, and it will be for him to approach the study of such species armed with specific questions awaiting answer in the field or laboratory. We venture to think that, far from any antagonism existing between the older and newer methods, the introduction of statistics in the Galtonian sense cannot but give a great impetus to observational work. It may be added that the periodical is really cosmopolitan, and the editors invite contributions in German, French or Italian, as well as in English. We cordially wish the new journal the success which it merits.

ANNIVERSARY MEETING OF THE ROYAL SOCIETY.

THE anniversary meeting of the Royal Society was held as usual on St. Andrew's Day, November 30, when the annual report of the Council to the Fellows was presented. Among the subjects mentioned in this report is the proposal to establish a British Academy, which was discussed at a special meeting of the Society held in May last.

Reference is made by the Council to the subject of the tenure of office of the secretaries, which was recently raised again. A memorial "praying the President and Council to take into immediate consideration the advisability of limiting the tenure of office of any future treasurer or secretary," and also a memorial expressing the decided convictions of the memorialists that the change advocated by the preceding memorial would not be in the interests of the Society, were taken into consideration at the meeting of the Council on November 7. It was proposed, as a resolution, "That in the opinion of this Council it is desirable that the secretaries should not be so re-elected as to hold office for a period exceeding ten consecutive years, this resolution not to apply to the present holders of office," and, after considerable discussion and the consideration of various amendments, the resolution was carried.

As already announced, in consequence of his appointment as Principal of the University of London, Prof. Rücker has resigned his office as secretary, and is now succeeded by the distinguished mathematician and physicist, Dr. Joseph Larmor.

The address of the president referred to the scientific work of the Fellows and Foreign Members deceased since the former annual meeting, and a few investigations commenced or carried on in the course of the year. The work of this year's medallists was described as follows:—

COPLEY MEDAL.

Prof. J. Willard Gibbs, Foreign Member, R.S.

The Copley Medal is awarded to Prof. J. Willard Gibbs, a Foreign Member of this Society, for his contributions to mathematical physics.

Although Horstmann had demonstrated, between 1869 and 1873, the applicability of the mechanical theory of heat to the elucidation of the phenomena attending dissociation, J. Willard Gibbs was the first to apply the second law of thermodynamics to the exhaustive discussion of the relations between chemical, electrical and thermal energy and capacity for external work. His great contribution to this subject appeared in the *Transactions* of the Connecticut Academy in two parts, the first in 1875 and the second in 1878. In this paper, which opens with a discussion of the criteria of equilibrium and of stability as applying to a material system, the conditions of equilibrium prevailing in both homogeneous and heterogeneous systems of gaseous, liquid and solid materials are considered in a highly generalised form; and it is shown by Gibbs that Deville and Troost's experimental values of the density of nitrogen peroxide at different temperatures, and Playfair and Wanklyn's results obtained with mixtures of nitrogen peroxide and nitrogen, can be interpreted quantitatively with the aid of his fundamental gas equation.

The most important result of Gibbs's work, from a chemical standpoint, is the so-called "phase rule," the law which governs the general case of complete heterogeneous equilibrium. This law, which was developed theoretically, states that a system in complete heterogeneous equilibrium must be composed of at least n different molecular components if it consists of $n+1$ different phases.

The application of the phase rule has been repeatedly verified experimentally under a great variety of aspects. During the last few years the recognition of the law has led, amongst other important results, to a complete systematisation of our knowledge concerning dissolution of solid substances, the distribution of a solute between two immiscible solvents, and to the formation of double salts and of racemic, pseudo-racemic, non-racemic

and externally compensated substances. The phase rule has also been applied with complete success by van 't Hoff to the elucidation of the formation of oceanic salt deposits. In fact, Willard Gibbs's generalisation is applicable to all cases of reversible chemical interchange, and consequently to chemical change generally.

ROYAL MEDAL.

Prof. William Edward Ayrton, F.R.S.

A Royal Medal is given to Prof. William Edward Ayrton, F.R.S., for his contributions to electrical science.

The services rendered by Prof. Ayrton to science during the last twenty-seven years may be roughly grouped under two heads. He has carried out a large number of researches in pure physics, and he has taken a very prominent part in the development of the application of electricity to industry, which has been so remarkable a feature of the closing years of the nineteenth century. It is not here necessary to refer particularly to his researches, invention and inspiration under the second head. At all times he has been doing service under both heads. From 1873 to 1878, in Japan; from 1879 to 1884, at Finsbury; and from 1884 to the present time, at the Central College, Kensington, he has acted as professor of physics; he has arranged large laboratories, and through his own example in research he has inspired many students, who are now carrying out investigations of their own.

A large number of papers contributed, sometimes alone and sometimes in partnership with others, to the Royal Society *Proceedings* and *Transactions* and other scientific publications, while belonging to the second group above mentioned, have greatly assisted in pure physics.

It is not out of place to quote a published remark of the late Prof. Clerk Maxwell in reference to the work of Prof. Ayrton and a colleague in Japan, that they had moved the centre of gravity of electrical science greatly eastward.

ROYAL MEDAL.

Dr. William Thomas Blanford, F.R.S.

The other Royal Medal is conferred upon Dr. William Thomas Blanford, F.R.S., for his work in connection with the "Geographical Distribution of Animals."

Dr. W. T. Blanford received his scientific education at the Royal School of Mines, and, after special instruction in the methods of geological surveying under Prof. (afterwards Sir Andrew) Ramsay on the English Geological Survey, proceeded in 1855 to take up a post on the Geological Survey of India.

Between the years 1855 and 1868, when he was engaged in surveying different parts of India and Burma, he published a number of valuable papers on Indian geology, and upon malacology and other branches of natural history, based on observations made during his travels as a geological surveyor.

In 1868 he was appointed to accompany the expeditionary force under Lord Napier to Abyssinia in the capacity of naturalist, and his observations on the geology and fauna of the country are published in a number of communications to scientific journals and in his work, "Observations on the Geology and Zoology of Abyssinia," published in 1870.

Between 1868 and 1872, Dr. Blanford returned to his work on the Geological Survey of India, and as the result of his labours in Sind, Cutch, the Deccan and other parts of the country, a number of memoirs dealing with geology, malacology and ornithology were published by him. In 1872 he was selected to act as naturalist to the Persian Boundary Commission and the results of his observations appeared in a work, "Eastern Persia, vol. ii., Zoology and Geology," which was published in 1876.

Returning to India, he not only carried on the usual survey work, but, in conjunction with Mr. H. B. Medlicott, prepared the important "Manual of the Geology of India," 3 vols., 1879. In this work a most valuable summary of the geological observations which had been made upon all parts of the Indian Empire is given, with a discussion of the age and relationships of the formations of that vast district.

Since his return from India, in 1882, Dr. Blanford has been continuously engaged in zoological and geological researches. His memoirs on the rocks of India and Australia which exhibit glacial conditions, and on kindred subjects, have been most valuable contributions to geological science. Equally important have been the two addresses on "Geological Nomenclature" and "The Permanence or otherwise of Ocean Basins," which he delivered in his capacity of president of the Geological Society in 1889 and 1890. In the last-mentioned address he has laid down principles and established conclusions which have given a new aspect to the study of the geographical distribution of animals.

"The Fauna of India," published under the authority of the Secretary of State for India in Council (8 vols., concluded in 1898), was edited by Dr. Blanford, who has contributed three volumes on birds and mammals. This work has been most favourably received by the scientific public and is looked upon as the standard authority of Indian vertebrates. His contributions to this work constitute his special claim to a Royal Medal.

Dr. Blanford is one of the few men who are regarded as an authority on geology, palæontology and zoology, to each of which branches of science he has largely contributed.

DAVY MEDAL.

Prof. George Downing Liveing, F.R.S.

The Davy Medal is awarded to Prof. George Downing Liveing, F.R.S., for his contributions to spectroscopy.

Prof. Liveing's papers on spectroscopic subjects have been mainly published during the last quarter of a century in conjunction with Prof. Dewar, and have appeared for the most part in the *Proceedings* of the Royal Society. They make up a record of patient, accurate, conscientious labour, and, taken together, constitute one of the most valuable contributions to this department of chemical physics yet made by British workers.

SYLVESTER MEDAL.

Prof. Henri Poincaré, Foreign Member, R.S.

The Sylvester Medal, given this year for the first time, is awarded to Prof. Henri Poincaré, a Foreign Member of this Society, for his many and important contributions to mathematical science.

Prof. Henri Poincaré's mathematical writings display very great originality, independence of thought and far-sightedness. The number of the memoirs and works which he has published is extraordinary, and the wide range of subjects in pure mathematics and its applications to astronomy and physics which they cover is equally remarkable. The bond of unity which connects his investigations is that nearly all have a more or less intimate connection with the study of differential equations. He has dealt with the theories of linear differential equations, of ordinary non-linear differential equations and of partial differential equations, with striking results in each theory; and each is associated with a department of his other important researches.

In the theory of linear differential equations, Fuchs had called attention to the substitutions by which different particular integrals are interchanged at the critical points. The substitutions form a group, and (at any rate when the equation is of the second order) there exist automorphic functions which are unchanged by the operations of the group. M. Poincaré has constructed these functions and shown how by means of them a complete integration of the linear differential equation can be effected (*Acta Mathematica*, t. iv.). He has devoted five classical memoirs (*Acta Mathematica*, i., iii., iv., v.) to a profound study of the automorphic functions and Fuchsian and Kleinian groups. Closely related to the same study are his delicate researches as to the topology of loci in space of n dimensions, and a number of contributions to the theory of algebraic functions.

In the theory of ordinary differential equations (not linear) he has introduced a new method of dealing with the question of the existence of a solution, and has shown how various methods of approximating to a solution may be utilised for solving the problem which gives rise to the differential equation. This lies at the root of his investigations in connection with the equations of dynamics and the special problem of gravitational astronomy —that of n bodies. He has shown that G. W. Hill's periodic solution of the problem of three bodies is one of an infinite system. M. Poincaré has also discussed from the point of view of modern analysis the methods of solution in periodic series which are associated with the name of Laplace and with the problem of the stability of the solar system, and has been led to give the first complete theory of series of the kind now called "asymptotic" and to point out their uses in analysis.

Mathematical physics requires the investigation of certain

partial differential equations, and the problem arises to develop a formula from which the solution, subject to boundary conditions, can be calculated. The problem can in any case be reduced to the discovery of what is now called a Green's function. To Poincaré is due perhaps the most feasible means yet devised for arriving at these functions. A general analytical theory has also been given by him of a somewhat different problem, required in theories of vibration and electrical oscillation. The diffraction of light has also been discussed by him in an elaborate memoir.

He has besides enriched pure mathematics with researches in the theory of numbers and on double integrals. In applied mathematics he has obtained remarkable results with regard to the figures which can be assumed by rotating fluid. To dynamical astronomy he has contributed, not only memoirs, but a monumental work in three volumes—"Les Méthodes Nouvelles de la Mécanique Céleste."

Finally, allusion may be made to the services which M. Poincaré has rendered to a number of branches of mathematical physics, by critical presentation of the work of others in published courses of lectures.

The officers and Council elected for the ensuing year were the Fellows whose names have already been given (p. 34), with two others to supersede two Fellows who found themselves unable to serve (p. 85).

On the evening of Saturday, the Fellows and their friends dined together in the Whitehall Rooms, when, to quote the *Times* report, "no Cabinet Minister and only one ex-Minister—Mr. John Morley—was present. Thus the calm discourse of the men of research was undisturbed by even the suggestion of political strife." It might also have been added that thus do Ministers of State manifest their indifference to associations having no political significance.

NOTES.

WE regret to announce the death of Sir William MacCormac, the distinguished president of the Royal College of Surgeons.

PROF. YVES DELAGE has been elected a member of the section of anatomy and zoology of the Paris Academy of Sciences in succession to the late Prof. Lacaze-Duthiers. Prof. Gouy, professor of physics in the University of Lyons, has been elected a correspondant of the Academy in succession to the late Prof. Raoult.

IN response to appeals made by the Dover Chamber of Commerce to the Trinity House to place wireless telegraphy installations on the lightships in this part of the English Channel, an intimation has been received by the Chamber that the matter is under consideration by a special inter-departmental committee.

THE National Antarctic Exploration ship *Discovery* arrived at Lyttelton on Nov. 23. The ship has been dry-docked for caulking, having sprung a leak, though not a serious one.

MR. JONATHAN HUTCHINSON, F.R.S., is about to proceed to South Africa with the view to study the cause of leprosy. He will proceed to Robben Island, and will probably go on to Natal and Basutoland. His object is especially to obtain facts as to the use of dried and badly salted fish. Leprosy is a comparatively new disease in Cape Colony, and quite so in Natal and Basutoland. Thus these districts offer exceptional opportunities for ascertaining its cause.

THE Berlin correspondent of the *Times* reports that the German Imperial Estimates include the sum of 150,000 marks (7500*l.*) to be devoted to the prevention of tuberculosis and to the investigation of that disease. The sum will be largely applied to the promotion of research with the object of settling the question of the identity of tuberculosis in human beings and in animals. For the promotion of markets for agricultural produce and for the support of scientific, technical and kindred undertakings in the interest of agriculture a sum of 90,000 marks will be demanded, as against 50,000 marks last year.

EX-GOVERNOR EYRE, who died on Saturday at the age of eighty-six, was less known perhaps for his geographical work than for his action in connection with the disturbances in Jamaica thirty-six years ago. Yet he was an intrepid explorer, and in 1843 he received the Founder's Medal of the Royal Geographical Society for his explorations in Australia. He crossed the Australian continent overland from Sydney in the east to Swan River in the west, and investigated the then unknown shore of the Great Australian Bight between King George's Sound in Western Australia and Port Lincoln in South Australia. In 1845 he published the results of his explorations in a work entitled "Discoveries in Central Australia."

A SPECIAL expedition, under Dr. Charles Balfour Stewart, has just been sent by the Liverpool School of Tropical Medicine to the Gold Coast and to the gold-mining districts of that colony, to conduct a series of operations there with a view to improve the conditions of health and sanitation. Dr. Stewart was to have sailed for Cape Coast Castle on November 16, but his departure had to be delayed as the municipal authorities of Liverpool requisitioned his services to deal with an outbreak of plague in the city. The lines on which Dr. Balfour Stewart will proceed will be similar, so far as possible, to those now being followed by the Sierra Leone expedition of the Liverpool School under Dr. Logan Taylor.

THE death is announced of Mr. Samuel Rowles Pattison, who for some years was a member of Council of the Geological Society and its honorary legal adviser. In early life he resided at Launceston, where he made a collection of fossils from the limestone of Petherwin, and assisted by his local knowledge both De la Beche and John Phillips. He contributed papers on local geology to the *Transactions* of the Royal Geological Society of Cornwall and the Royal Institution of Cornwall from 1840 to 1860; and in the *Quarterly Journal* of the Geological Society of London he recorded the occurrence of auriferous quartz-rock in north Cornwall. In 1858 he published a work entitled "The Earth and the Word; or Geology for Bible Students." Mr. Pattison, who had attained the ripe age of ninety-two, died on November 27.

THE results of an analysis of the returns relating to the outbreak of small-pox in London are given in an article in Saturday's *Times*. There have been 349 completed cases, that is, cases which have ended in death or recovery, since May last. Of these 349 patients 181 were males and 168 females. The number of deaths was 116, and the rate of mortality was three times as great among the unvaccinated as among the vaccinated. The following points brought out by the classification of the cases are instructive:—(1) All the cases under five were unvaccinated, and out of 23 there were 19 deaths; (2) all the children under ten were unvaccinated except one, and out of 42 there were 29 deaths, all the deaths being of unvaccinated children; (3) out of a total of 81 children under fifteen years 57 were unvaccinated and 38 died. Only one death out of the 38 took place in a vaccinated child; of 24 vaccinated children 23 recovered. These facts show the fatality of the disease among young children and the protection afforded by primary vaccination against attack in the first instance and against a fatal result in the second. The protection diminishes progressively after childhood, but the rate of mortality remains enormously higher among the unvaccinated in every age period.

THE results of several series of experimental work in connection with the cultivation of hops were described at the conference of hop-growers held at the South-Eastern Agricultural College last week. The object of the meeting was to receive and discuss the reports of the various experiments upon hops that have been carried out by the College during the past

season. These experiments have in many cases been going on continuously on the same plots since 1895, so that the results are beginning to show a measure of consistency that is not immediately attainable in field trials. Training experiments at Wye are favourable, on the whole, to the systems of wide planting and broad alleys. The umbrella system of training has generally given the maximum weight per acre, but has various disadvantages compared with the Butcher system. Cutting the bine at picking time, as is done when hops are grown on poles or on some wire systems, is found to result in a considerable loss of material to the hop plant, and weakening and loss of crop in the succeeding year. Stripping off the lower leaves and laterals is found to be harmful in seasons of short growth and without effect when the plant is vigorous. Cultivation experiments at Goudhurst, where a plot has now carried a full crop for seven years though without any cultivation beyond surface hoeing, aroused considerable discussion; the trial is to be extended to other soils. Manurial experiments have been carried out on various soils in Kent and Surrey and deal chiefly with the use of mineral manures; the soil is shown to be the main factor in the results attained, especially in the cases where the cultivation has been extended from the typical hoplands to sandy or clay soils.

THE third number of vol. ii. of the *West Indian Bulletin*, just received from Barbados, contains a good deal of useful information relating mainly to cacao and sugar-canes. Mr. Maxwell-Lefroy, entomologist to the Imperial Agricultural Department, has visited the island of Grenada to investigate the prevalence of an insect pest known as "thrips," affecting the leaves and pods of the cacao, and apparently to a less extent the leaves of cashew, guava and Liberian coffee. The insect is found also on cacao in the islands of St. Vincent, St. Lucia and Dominica, but is not known in any other part of the world. Thus far its depredations have not been of a very serious character, and to prevent its becoming a greater plague advice is given to the planters as to the methods which should be adopted to suppress it. Mr. Howard, the mycologist, deals with the fungoid diseases of cacao in the West Indies, summarising the results obtained by the Department in recent investigations. The subject is fully treated in three divisions—pod diseases, stem diseases and root disease. Mr. William G. Freeman, the technical assistant, in a note on the formation of cane-sugar in the sugar-cane, endeavours to give some idea of the possible sequence of events, but more investigation is necessary to clear up many doubtful points—we require to know, for instance, the first product of assimilation and the true relationship to each other of glucose and cane-sugar. Amongst other contributions are Sir W. T. Thiselton-Dyer's note on sugar-cane disease, and Mr. Noël Deerr's article on the distribution of the constituents of the sugar-cane in a Demerara factory and their utilisation as manure. There is an illustrated article on bud variation in the sugar-cane. Information has been collected from the various islands showing the planting and crop seasons of the sugar-cane. A full description of Barbados sour-grass, *Andropogon pertusus*, is given; and the desirability of introducing insectivorous birds from other countries to prey on the insect pests which cause so much destruction in the West Indies is discussed, but the conclusion arrived at seems to be in favour of encouraging the propagation of the local Barbados blackbird and to keep out the East Indian myna or starling, fearing the latter would become a worse pest than the insects.

A PRELIMINARY report of the international balloon ascents of June 13 has just been received. The places from which the ascents were made were Trappes (Paris), Chalais-Meudon, Strassburg, Berlin, Vienna, Pavlovsk (St. Petersburg), Moscow and Bath. In six cases the unmanned balloons were lost, or the records are not forthcoming. The greatest altitude, 14,800 metres, was attained from Trappes, where the lowest temperature, $-51^{\circ}\cdot4$ C., was recorded. The ascent took place about 8h. a.m. temperature at starting, $10^{\circ}\cdot4$, at 6090 m., -25°, at 10,900 m., -50°. At Strassburg the unmanned balloon ascended at 3h. 46 m. p.m., temperature 16°, and went through a thunderstorm cloud; at 2800 m. the temperature was 0°, at 4500 m. -10°, at 5400 m. -15°; the greatest height reached was 5700 m., temperature -17°. Another balloon which ascended about the same time reached an altitude of 10,400 m. and the lowest temperature recorded was $-49^{\circ}\cdot9$. One of the balloons sent up from Berlin reached a height of 9315 m., temperature $-43^{\circ}\cdot5$. From Vienna an unmanned balloon left the earth at 8h. a.m., temperature 22°; at 5000 m. -20°, and at 8900 m. -63° were recorded. Several manned balloons took part in the experiments; one of two from Vienna, carrying Archduke Leopold Salvator and Captain Hinterstoisser, ascended to 3500 metres, where a temperature of -4° was recorded.

MR. C. V. DRYSDALE communicated to the Institution of Electrical Engineers last week a description of a new form of permeameter for testing the magnetic qualities of iron and steel in bulk. A special form of hollow drill is used to drill a hole $\frac{5}{8}$ inch deep in the material to be tested; this hole has its upper part conical, and the small central pin left standing is $\frac{1}{10}$ inch in diameter. Into this hole fits a soft iron plug on the lower part of which are wound the magnetising and testing coils. There is thus formed a miniature permeameter in which nearly the whole of the magnetic circuit is of the material under test. By connecting the coils in the plug with suitably graduated instruments the permeability, retentivity and hysteresis may be very easily tested. Curves and figures which were published showed that the instrument gave very consistent results, although, as was pointed out in the discussion, they did not agree as well as they might with the values usually obtained by other permeameters. But the simplicity of the apparatus and the ease with which a test can be obtained (if, that is, the drills can be made to act with uniform accuracy) should give it considerable commercial value. The dynamo manufacturer requires chiefly a rough guide to the permeability of the casting he is going to use and does not need very rigid scientific accuracy, and such a guide Mr. Drysdale's instrument should be able to provide. In fact, any method which really only tests a very small portion of the bulk, whether *in situ*, as in this case, or after it has been cut off, can never be thoroughly satisfactory.

PROF. LEBEDEW, of Moscow University, describes in Drude's *Annalen der Physik* for November, 1901, a research by means of which he has succeeded in demonstrating experimentally the pressure of light. A translation of his paper is now appearing in the *Electrician*. It followed as a consequence of Maxwell's theory that the combined effect of the electrostatic and electrokinetic stresses is a pressure in the direction of the propagation of the wave numerically equal to the energy in unit volume, and Maxwell pointed out that "the concentrated rays of the electric lamp falling on a thin metallic disc, delicately suspended in a vacuum, might perhaps produce an observable mechanical effect." It was this effect that Sir William Crookes was thought to have obtained in his radiometer, but the magnitude proved many thousand times too great. Prof. Lebedew eliminated the radiometer action by using a large bulb with high exhaustion and by excluding rays capable of heating the tube walls. The radiometer vanes were of very thin aluminium foil suspended by a glass fibre, and the source of light the electric arc. The results obtained agree with the theoretical results of Maxwell within 10 per cent., and show that the pressure is directly proportional to the energy of the incident light and independent of the colour.

A CONCISE handbook of the geology of the city of New York has been published by Mr. L. P. Gratacap, of the American Museum of Natural History.

THE periodic variations of glaciers are dealt with by Dr. S. Finsterwalder and M. E. Muret in the sixth report of the International Commission on Glaciers (*Arch. Sc. Phys. et Nat.* Genève, tome xii., 1901).

"ICE CAVES and Frozen Wells as Meteorological Phenomena" is the title of a paper by Mr. H. H. Kimball (*Monthly Weather Review*, August 1901). The author's observations were made in New York co. and Vermont, and he concludes that the phenomena are due to the cold air of winter circulating to unusual depths below the surface and freezing the small quantity of water with which it comes in contact. The ice may not entirely disappear during the following summer, but continue under certain conditions to accumulate for ages.

IN the Memoirs of the Geological Survey of India (vol. xxxi. part ii., 1901) there is a geological sketch of the Baluchistan Desert and part of eastern Persia, by Mr. E. Vredenburg. The rocks comprise marine strata ranging in age from Upper Cretaceous to Upper Eocene. Interbedded with them is a large proportion of volcanic rocks, and these, together with numerous igneous intrusions, form the chief hill masses. Considerable areas are occupied by Siwalik strata, land deposits of Miocene age, which consist of conglomerates, friable sandstones, and clays frequently white or brightly coloured in various tints of pale terra-cotta, ochre or green. Much of the low ground is concealed by modern alluvium and sand dunes. Except in the unusual event of a storm the plains are absolutely dry, and when such an occurrence takes place the flood seldom lasts more than an hour. Then the water rushes through a network of irregular and ever-shifting furrows, rolling along with it large boulders which rattle loudly as they come into collision. These floods by their suddenness constitute a source of danger to the flocks, especially to sheep and goats, which may be carried away if not driven off in time by the shepherds. In the western portion of the country examined there are several recent volcanoes, one of which still shows signs of activity.

THE artesian waters of Australia were dealt with by Mr. J. P. Thomson in a paper read at a recent meeting of the Royal Geographical Society of Australia. Although the whole of the Australian colonies have taken an active part in the somewhat minute and altogether elaborate search for artesian water, it is to Queensland that the greatest credit is due for having discovered the existence of an unlimited and practically inexhaustible supply in the lower cretaceous formation that underlies the vast rolling downs of the western portion of that State. Several of the inland towns and many parts of the western district are now watered by numerous artesian wells or bores. In some remarks upon the subject, the president of the Society, Sir Hugh Nelson, pointed out that up to the present time the amount of artesian water brought to the surface at the bores has had very little effect as an irrigating agent upon the great areas of land in the west during seasons of drought. This water is valuable for drinking purposes for stock, but stock cannot exist upon water alone—they require herbage, and the supply of water is not plentiful enough to irrigate the runs. The Hon. A. C. Gregory also explained that artesian water contains a small percentage of saline matter, and while it might be used for irrigating small areas of cultivation the saline properties of the water have the reverse of a beneficial effect upon the land when the water is used to irrigate large tracts of country.

WE have received a copy of "A Catalogue of Crustacea and Pycnogonida in the Museum of University College, Dundee," by Prof. d'Arcy W. Thompson. The list is a long one.

THE Egyptian Government has just issued a series of "Notes for Travellers and Sportsmen in the Sudan." These give full information with regard to the game of the country and the conditions under which it may be killed. The regulations for the protection of the rarer species seem well calculated to attain the end in view—at least for a time.

THE nesting and other habits of one of the North American cat-fishes of the genus Amiurus forms the subject of a paper, by Mr. A. C. Eycleshymer, in the *American Naturalist* for November. "Although repeated efforts were made," writes the author, "to find the nests, they were unsuccessful until June 8, 1896, when three nests were found in Fowler Lake, Wisconsin. Two of these were in pieces of stovepipe, the third in an old pail. The nests were in clear water, near a bold rocky shore, and at a depth of four or five feet; all contained embryos, and each was guarded by a parent fish—which one I did not ascertain."

THE latest issue of the *Zeitschrift für Wissenschaftliche Zoologie* (vol. lxx. pt. iii.) contains two papers, one, by Dr. R. Hesse, on the eyes of arthropods (being the seventh of a series on the visual organs of invertebrates), and the second, by Herr C. Rabl, on the origin of limbs. In the latter memoir much attention is devoted to the question whether fins, as Gegenbaur thought, are derived from modified gill-arches, or whether, as suggested by Balfour and Thacher, from lateral folds, the author favouring the latter view. The diagrams illustrating the various modifications of carpal and tarsal structure in the lower vertebrates are especially interesting.

To the November number of the *American Naturalist* Mr. H. L. Osborne communicates some interesting notes on axolotls from Colorado and Dakota. Two kinds of metamorphosis occur during the passage of these creatures from an aquatic to a terrestrial existence, first of all in the development of the limbs and lungs, the alteration of the circulatory system and the maturation of the reproductive organs. But there are also secondary changes, which may occur either early or late in life. In some districts axolotls pass into the adult amblystoma state when quite small; but in Mexico the secondary changes never take place at all, so that the animal, although adult in other respects, remains in the aquatic condition throughout life.

AN important paper in the November issue of the *Quarterly Journal of Microscopical Science* is one by Mr. E. S. Goodrich on the pelvic girdle and fins of the "fringe-finned ganoid" fish Eusthenopteron. The specimen on which the communication is based is from the Devonian of Canada, and is preserved in the British Museum. It is remarkable as being the only known example among the numerous remains of the extinct representatives of the group in question in which the pelvis and fins are preserved in a complete state and showing their natural relations to one another. Although the structure of the fin-rays shows a curious approximation to the type of the more specialised modern bony fishes, in other respects the pelvic fins of this fish show signs of being derived from a type allied to that which persists in the Queensland lung-fish (Ceratodus). Another article in the same journal, by Mr. E. P. Allis, deals with certain parts of the anatomy of the small shark known as *Mustelus laevis*.

THE *Transactions* of the New Zealand Institute for 1900 contain a large number of papers on the zoology of the colony, as well as others connected with acclimatisation and stock-breeding. Among the former, reference may be made to Prof. Benham's description of the New Zealand lancelet, of which only two examples appear to be known. This form is now referred to the genus Heteropleuron, the commonest type of the group in the southern hemisphere, under the name of *H. hectori*. In

two other communications the same writer discusses the New Zealand earthworms, describing three new species, under as many generic heads. Prof. Dendy and Miss Olliver jointly describe a new freshwater leech of the genus Glossiphonia, while the former contributes a fourth paper on the land planarians of the colony.

THE acclimatisation and variation of Salmonidæ in New Zealand form the subject of a paper in the *Transactions* of the New Zealand Institute for 1900 by Mr. A. J. Rutherfurd, in which it is concluded that greater success is likely to attend the introduction of the north Pacific salmonoids than that of *Salmo salar*, which is a more delicate fish, unlikely to find what it requires in an ocean so far removed from its native habitat. In regard to trout, the author is of opinion that "whatever variety we liberate of the ordinary species of trout, it will develop into a *Salmo novae-zealandiae*, suited to the water in which it is liberated, and corresponding with trout in similar localities in the Northern Hemisphere more closely than with the varieties found in the more northern latitudes of our mother-country." Considerable interest also attaches to a paper by Mr. T. White on breeding black merinoes, of which there are now several flocks in the colony. Although the wool does not fetch so high a price as the best selected white it is really more valuable, as the price is the same for the whole fleece.

A CIRCULAR which we have just received from Messrs. Hirschberg and Oestergaard, Berlin, provides us with another example of German enterprise. This firm has produced a large wall map of the British Isles and of the world, showing the British colonies in a distinctive colour, and special offers are being made to English newspapers to take up the map and sell it to their readers. The map is 53 in. by 42 and is printed in twelve colours. In a space left at the top the title of the newspaper adopting the map, and other particulars of local interest, will be inserted as desired. As a number of newspapers have taken up the map there is apparently no objection to its German origin. But how is it that our geographical publishers cannot make similar arrangements with newspapers, and so prevent, in a sense, the war from being carried into our own country? It certainly seems strange that Germany should find it worth while to supply us with cheap maps of the British Isles and the Empire.

THE "Year Book of the Scientific and Learned Societies" (London: C. Griffin and Co., Ltd.) is a very handy guide to organisations existing in the British Isles for the promotion of knowledge. The societies and other institutions are arranged in fourteen different departments, according to their objects, and particulars are given as to officers, meetings, conditions of membership, and publications of each. In addition, lists are given of papers read before each society from January, 1900, to June of the present year. The reason why the papers read during eighteen months are catalogued instead of those read in a calendar year is that it is intended in future to make the Year Book correspond as closely as possible with the sessional year of the societies dealt with in it. Subsequent volumes will therefore record the papers read before each society between September and June, and they will be published as early as possible in the succeeding session. This change will be an additional convenience to those who use the Year Book as a manual of ready reference or a general review of Great Britain's annual contributions to scientific knowledge.

THE work of John Mayow, a pupil of Robert Boyle, was touched upon by Dr. J. B. Cohen, in an address recently delivered before the Yorkshire College Scientific Society. Mayow was certainly a genius, and some of his observations are remarkable for their shrewdness and depth, but they have often been misrepresented, and Dr. Cohen gives some interpretations of them which should interest students of the history of chemistry. His treatise on combustion was completed before the birth of the phlogiston theory, and was revived a century later, after Priestley had discovered oxygen, and the phlogiston theory was breaking down. Referring to Mayow's experiments on hydrogen and nitric oxide, Dr. Cohen remarks, "it must suffice to say that he anticipated Priestley in recognising both these as distinct kinds of gases, differing from, but possessing the same elasticity as air. Although Priestley's view of the composition of dephlogisticated air has much in common with that of Mayow's nitro-aërial particles, there is plenty of evidence to show that Priestley's ideas were formed quite independently. It must be admitted, however, that they show little advance on those of a whole century before."

THE recent work of M. Moissan on the properties of pure calcium has shown that the description of this element current in the text-books was by no means an accurate one, and from the work of M. Guntz, published in the current number of the *Comptes rendus*, it would appear that the properties of pure barium also differ considerably from those hitherto assigned to it. The starting point of the work is barium amalgam, and by the electrolysis of a saturated solution of barium chloride with a mercury kathode it would appear to be quite easy to prepare several kilograms of a 3 per cent. barium amalgam. It is the separation of the mercury from this amalgam which has proved to be such a difficult matter. M. Maquenne, for instance, who attempted to distil off the mercury, was quite unable to obtain a coherent ingot of barium in this way. M. Guntz has found that the secret of success in this experiment is to apply the heating gradually; the amalgam is placed in an iron boat in a wide porcelain tube and the tube heated by a coil of fine platinum wire, brasqued by a protecting coating of alumina and magnesia. By means of this electric furnace it has been found possible to raise the temperature as slowly as 200° C. per hour, and finally to maintain the tube, 50 mm. in diameter and 300 mm. long, at 1200° to 1300° C., with an expenditure of 600 to 700 watts. Working in this way a good yield of pure barium has been obtained at 1000° C. The barium thus obtained when freshly cut has a white silvery lustre; it is soft, a little harder than lead, and is extremely oxidisable in the air, often catching fire when attempting to remove it from the boat by means of a hard body. It resembles lithium and calcium in dissolving in liquid ammonia, and attacks easily water, alcohol and even an alcoholic solution of baryta.

THE additions to the Zoological Society's Gardens during the past week include a Green Monkey (*Cercopithecus callitrichus*) from West Africa, presented by Dr. A. E. Neale; two Short-eared Owls (*Asio brachyotus*), one Short-eared Owl (*Asio brachyotus*), European, presented respectively by Mr. W. Jamrach and Mr. C. W. Burnett; a Variegated Sheldrake (*Tadorna variegata*) from New Zealand, purchased.

OUR ASTRONOMICAL COLUMN.

THE NEW STAR IN PERSEUS.—Sir Norman Lockyer recently communicated to the Royal Society some further observations of the new star in Perseus made at the Solar Physics Observatory in continuation of the last previously recorded (Roy. Soc. *Proc.*, vol. lxviii. p. 399). In the present paper, which brings the information up to the end of September, it is first pointed out that the short period light variations have ceased and that the Nova was gradually becoming fainter, reaching about magnitude 6·7. In the visual spectrum the nebular line at wave-length 5007 was the strongest. Photographs of the spectrum showed that since last April a great change has taken place. The lines then were very broad and ill defined, but are now much narrower with better defined edges. The lines of hydrogen, which were the strongest in the spectrum have become comparatively very

weak. Other lines have made their appearance, the strongest of which are 3868 and 3970, 4364 and 4720. The first is an unknown line strong in the spectra of planetary nebulæ, while the other three are of unknown origin. It is suggested that the second line (3970λ) is not the line of hydrogen at Hε, as the other hydrogen lines in the spectrum are so weak. There is, further, a new line in the ultra-violet at wave-length 342 (about), which Gothard has independently recorded. It is interesting to note that the new gas lines show a structure somewhat similar to that of the hydrogen lines in earlier photographs. The enhanced lines of iron, magnesium, &c., which were such a conspicuous feature of the first photographs, have entirely disappeared, and the probability is that the bright lines now, other than hydrogen and helium, belong to gases the terrestrial equivalents of which have not been found.

VARIATION OF LATITUDE.—Prof. S. C. Chandler has made an exhaustive examination of the old records obtained with the reflex zenith tube at Greenwich from 1852–82, which were abandoned as being affected with undiscoverable sources of instrumental error, and finds that for the periods providing continuous measures throughout the year they yield most valuable data for the determination of latitude variation, and that this anomaly, unknown at the time, was most probably the cause of the want of agreement among the observations. The two periods yielding continuous values were 1857–63 and 1864–70 (*Astronomical Journal*, vol. xxii., No. 511.)

DETERMINATION OF THE ELEVATION OF METEORS.—During the rather brilliant display of Perseids in August last a series of successful experiments was made by the observers at Juvisy Observatory to determine the heights of as many meteors as possible. Two stations, Juvisy and Croix-de-Berny (Antony), were chosen at a distance of 9·200 km. The number of meteors registered at both stations was 21, of which 8 fulfilled all the necessary conditions for the determination, and a table is given showing their calculated heights of appearance and disappearance, and also the resulting length of trajectory. The lowest record is 15 km. and the highest 119 km. (*Bulletin de la Société Astronomique de France*, November 1901.)

MERIDIAN OBSERVATIONS AT HARVARD COLLEGE OBSERVATORY.—In a separately published portion of vol. xli. of the *Annals of Harvard College Observatory* (No. 7, pp. 189–211) Mr. A. Searle gives an account of a series of special investigations which have been in progress with the hope of eliminating several systematic errors in the transit observations. It was thought that these might be due to the employment of ruled glass plates instead of spider threads, and for a time the latter have been substituted for trial. The result showed that the change produced no important difference in the discrepancies referred to. Personal equation with respect to magnitude was noticeable in both right ascension and declination when the transits were taken over inclined lines, as was the case with the ruled glass plates formerly used.

LENGTH OF THE TERRESTRIAL DAY.—Mr. R. S. Woodward has been investigating the extent to which the secular cooling of the earth and the fall of meteoric dust may affect the length of the terrestrial day. Attention is first drawn to the conclusion of Laplace that the day has not changed appreciably owing to secular cooling during the past 2000 years, but this was on the assumption that the earth is in the last stages of cooling. This the present author thinks an unnecessary and doubtful restriction, and proceeds, using the other conditions identical with those of Laplace, to develop a method of determining the effect on the length of day of the cubical contraction of the earth during any portion of, or during the entire history of, the process of secular cooling.

It is suggested that, contrary to the views of Laplace, Fourier and Poisson, the dissipation of the internal heat of the earth is not controlled by the atmosphere and oceans, but escapes as if they did not exist.

The main conclusion is that in the entire history of secular cooling of the earth the day may be shortened from this cause by as much as 6 per cent. of its original length. With respect to a definite time variation, it is concluded that the length of the day will not change, or has not changed, as the case may be, by so much as half a second in the first ten million years after the initial epoch.

The concluding portion of the paper deals with the effect of accumulations of meteoric dust. The distribution is assumed as uniform over the surface. Taking Newton's estimate of the number of meteorites falling daily, it is calculated that at least a million million years would elapse before a change of a quarter of a second would be produced. The effect of secular cooling is thus considerably more than that of meteoric accumulations. (*Astronomical Journal*, vol. xxi, No. 502).

PHYSIOLOGY AT THE BRITISH ASSOCIATION.

THE Section of Physiology was presided over by Prof. McKendrick, F.R.S., and the place of meeting was Prof. McKendrick's laboratory at the University. Despite the near approach of the date of the fifth triennial International meeting of Physiologists held at Turin in September, the Section was well attended by working physiologists, and the audiences were often large. Profs. Schäfer and Sherrington were vice-presidents, and amongst others contributing to the meetings were Sir Michael Foster, Sir John Sanderson, Dr. Theodore Beer, Dr. Brodie, Miss F. Buchanan, Dr. Burch, Prof. Gotch, Dr. A. A. Gray, Dr. Edridge Green, Prof. Marcus Hartog, Dr. Kennedy, Dr. Myers, Dr. Noel Paton, Prof. Waymouth Reid, Dr. W. H. R. Rivers, Prof. W. H. Thompson, and Dr. J. A. Wanklyn.

The proceedings of the Section commenced with the president's address. Prof. McKendrick took for his theme the relation of physical and chemical structure as understood at present to our conception of the structure of living matter. The president commenced by pointing to the progress which had been made by physiology in the quarter of a century that had elapsed since the previous meeting at Glasgow. Physiology in its progress had proven itself a living and logical inductive science grappling successfully with its problems by help of the same laws that physics and chemistry apply to non-living matter and its phenomena. In this respect it contrasted strikingly with subjects, *e.g.* human anatomy, which had been closely associated with it formerly in educational curricula.

Physiology had in the last quarter of the century proved fruitful of discovery to an astonishing extent. Many of its discoveries were of high practical value to medicine as well as of theoretical value. It had struck deep into the soil, acquiring many new data of extreme accuracy and obtaining much profounder insight in the concatenations of the machinery of life. The phenomena of muscular contraction—that prime event in biodynamics,—the process of secretion by gland cells, the mutual synergy of organs as illustrated by internal secretion, the functional architecture of the nervous system, the mechanics of rejuvenescence of protoplasm by sexual recombination (fertilisation), all these branches of the physiological tree of knowledge had, under the cultivation of the last five and twenty years, grown vastly in extent and yielded blossom and invaluable fruit. Facts more accurate and theories more profound had drawn their science closer to the elder sister sciences of more exact measurement and at the same time had created, it must be admitted, a gap between it and subjects with which it had formerly been usually associated in teaching. It had widened the educational field and educational worth of physiology, releasing it from former restriction to narrower technical applications. Save in mathematics, knowledge cannot be absolute in any domain of natural science. Physiology shared with the sister sciences their birthright of problems that were, to speak in paradox, the more insoluble the further one progressed toward their solution.

The animal body—the human body—was a machine of high complexity, constituted of many interrelated parts, called organs, the "simple" tissues and the "compound" tissues. A number of its phenomena had indubitably received their lasting explanation; but the difficulty of examining the machinery of living matter while still in living action was extreme. The first step of the chemist's analysis was to kill the substance; yet his goal was analysis of matter still alive. A number of thoughtful physiologists had returned in recent years to study of the unit of physiological structure, the cell. For the study of the phenomena of life an object more suitable than the undifferentiated single independently living cell was in many cases a simple tissue composed of numbers of such cells associated and highly differentiated, but all differentiated in the same way one as another. Hence the tendency of the modern physiologist to examine the powers and reactions of the simple tissues rather than of unicellular organisms such as amœba. It must be admitted, however, that in spite of all their labour in many respects their knowledge had not yet reached far. For

instance, the visible details of structure revealed in the cell by the most perfect modern microscopes in collaboration with all the elaborate technique of modern histology seemed to bring us in no perceptible degree nearer towards an explanation of the chemical and physical construction of the cell. But if the matter were considered fully it became evident that the phenomena of life depend on changes occurring in the interactions of particles of matter far too small even to be seen by the strongest magnification yet obtainable by microscopes.

The physicist and chemist had not been content, it was pointed out, with the investigation of large masses of dead matter. To explain many of the phenomena they met with they had had recourse to the conceptions of molecules and atoms and to the formulation of laws that regulate the movements of these units almost infinitely small. The conception of the characters and dimensions of the molecules of *living* matter had occupied certain of the astutest physicists. Clerk Maxwell had placed before the physiologist a curious dilemma. Either the germ could not be homogeneous, developing as it does into a complex being with its hundred thousand characteristics, or if structurally diverse it is so small that its number of parts is insufficient to give a basis for the development of all the characteristics inherent in and developed by it as it expands into the adult creature. Only another supposition was postulable, namely that the germ was not a material system entirely; the adoption of that last supposition was, of course, equivalent to resigning the problem as inaccessible to any method obtaining in natural science.

If, however, in the light of twenty-five years of additional knowledge since the time of Clerk Maxwell the problem were reexamined we were not led necessarily to the dilemma he propounded. A quarter of a century ago it seemed to so competent an inquirer as he that the number of organic molecules in the fertilised ovum would be too few to account for the transmission of hereditary peculiarities. It then seemed that the molecules would not amount to a million in number. But to-day, Prof. McKendrick urged, it was reasonable from existing data to suppose that the germinal vesicle might contain a million of millions of organic molecules. Complex arrangements of these molecules suited for the development of all the parts of a highly complicated organism might satisfy all the demands of the theory of heredity. Doubtless the germ was a material system through and through. The conception of the physicist was that molecules were in various states of movement; and the thinkers were striving toward a kinetic theory of molecules and of atoms of solid matter which might be as fruitful as the kinetic theory of gases. There were motions atomic and molecular. It was conceivable that the peculiarities of vital action might be determined by the kind of motion that took place in the molecules of what we call living matter. It might be different in kind from some of the motions dealt with by physicists. Life is continually being created from non-living material; such, at least, is the existing view of growth by the assimilation of food. The creation of living matter out of non-living may be the transmission to the dead matter of molecular motions which are *sui generis* in form.

Sir John Burdon Sanderson opened the ordinary work of the Section by communicating a paper on the use of the telephone for investigating the rhythmic phenomena of muscles. The communication was largely based on the recent researches of Miss Florence Buchanan. Sir John explained that it was well known that violent contractions of muscle are sometimes obviously rhythmical. The muscular rhythm he should deal with was of a different kind and seat of production to that of violent willed action. The latter had its origin in the rhythmic discharge of nerve-centres. But the muscles themselves seemed to respond rhythmically, not continuously, to even continuous excitation. Their rate of rhythm was of much higher frequency than that of the nervous system; it amounted to repetitions amounting to about 100 per second. The rhythmic variation in the contracting elements of the muscle was variation of, amongst other states, that of electrical tension. Wedenskii, of St. Petersburg, had used the telephone for investigation of this condition of the muscle. A certain note might be low, *e.g.*, A in the bass clef, and if they applied stimuli to the muscle at something like the rate of that pitch they could force the muscle to harmonise. If the stimuli were regulated to G instead of A it would correspond with G, if with B instead of A, with B. But if the frequency were increased to much higher the muscle showed the same response as before—they had always about the same note. The muscle had, therefore, within limits a period of phasic activity of its own.

The next communication made, on behalf of Dr. A. S. Grünbaum (Liverpool) and himself, by Prof. Sherrington (Liverpool), dealt with experiments on the brain of the chimpanzee. The brain of the chimpanzee is, after that of the gorilla, the brain which approaches most nearly to that of man himself. The experiments undertaken had been the ablation of certain portions of the cortex with the view to study the after effects upon the behaviour and movements of the animals observed. The cerebral cortical centre for the right hand had first been carefully exposed and delimited by excitation with faradic currents. All that region of the cortex which had under excitation provoked movement commencing in the right hand had then been destroyed. The immediate effect of the injury had been paralysis of the hand, with a less degree of paralysis of the wrist and shoulder. In the course of five weeks, however, recovery had been so marked as to restore to the hand its uses almost completely, as far as mere inspection could decide. The animal often used the hand and sometimes fed itself on fruit, &c., from it alone, without use at all of the left hand. The right arm had in the course of even a fortnight recovered its use for climbing, &c. Examination of the spinal cord for the degeneration of tracts following this lesion led to the discovery of an anthropoid feature in the cord not previously found in any spinal cord except the human, namely, a fully-developed "direct pyramidal" tract. In another individual a limited destruction of the cerebral cortex in the leg-region of the "motor" area produced at once severe but short-lasting paralysis of the leg, with immediate increase of the knee jerk. The paralysis seemed in the course of four weeks to have passed away, although there still remained marked exaggeration of the knee jerk. The spinal degeneration when examined revealed no direct pyramidal tract in this case: either, therefore, the existence of that tract is subject to great individual variation or the tract is not connected with the more mesial portion of the motor area. Ablation of the posterior part of the left inferior frontal convolution did not produce any obvious alteration either of the character or of the amount of the vocal sounds uttered by the animal. The animal "talked" as much and apparently as variedly after as before the cortical lesion. Regarding descending tracts which degenerated in the spinal cord after lesions of the cortex it was noteworthy that the lesions which produced spinal degeneration were in every case situate in front of the fissure of Rolando. A further point of interest was that the degeneration descending from lesion of the hand area extended down along the spinal cord as far as the top of the lumbar region. Microscopic specimens were demonstrated in illustration of these points.

Dr. Edridge-Green followed with a paper on colour-vision. He developed his well-known views on the classification of the various types of colour blindness. He urged the unsatisfactory character of the test followed in using Hohngren's coloured wools, and the advantage of replacing that test officially by a lantern-test. Dr. J. Wanklyn read a paper on arsenical pigmentation of the skin, and Dr. W. A. Osborn recounted observations on the physical properties of caseinogen salts in solution.

On Friday, September 13, the proceedings opened by a most lucid and interesting paper by Prof. McKendrick on the registration of sounds. His description was richly illustrated both pictorially and by experiment. It proceeded to deal with the subject in its historical development. The methods adopted for the registration of speech sounds from 1875 onwards were shown. The gradual evolution of the phonograph was traced, and of the methods employed for the analysis of the marks made upon the wax cylinder of that instrument. There were special characteristics about vocal sounds which distinguished them from all the sounds of musical instruments. Language would come to be recorded, not by such symbols as are used at present for words and syllables, but by less arbitrary and more reasoned systems. It had been suggested that the signs should indicate what had to be done by the vocal and articulating organs for the production of any given sound. Prof. McKendrick then examined the various theories put forward regarding the formation of vowel sounds. He spoke especially of the recent researches of Dr. Marès, of the Physiological Institute of the Sorbonne, Paris. Marès had approached the problem from a very original point of view, regarding the grouping of the vibrations, in the internal sequence rather than the external sequence, as of main influence. Using a syren with plates per-

forated according to the sequences observed in the flame pictures, &c., of vowel sounds and adding to the syren certain resonators which were faithfully moulded on the shapes taken by the mouth in utterance of vowels, Marès had succeeded in reproducing the vowel sounds with a degree of fidelity surpassing those of all previous efforts. Prof. McKendrick urged the phonographic registration of dialects. Such a collection of phonographic records would be of help to the science of language. How little could we tell to-day of the spoken sounds of ancient Sanskrit, of how Demosthenes spoke in Greek or Cicero in Latin; how little also of the exact accent of Shakspeare's English. Finally, a demonstration was given of the practical efficiency of the intensification of the sounds of a phonograph by causing their waves to fall upon a microphone and that instrument in turn to affect a loud-speaking telephone.

Dr. R. Kennedy (Glasgow) read a paper on return of voluntary movements after alteration of the nerve-supply by nerve-crossing or anastomosis. His experiments on animals had shown that when the nerve supplying the flexor muscles of a limb were divided and cross-united to the nerves supplying the extensor muscles, the animal in time regained the functional use of the limb, although the innervation of the muscle groups was reversed. The nerve-centres for the flexor and extensor muscles interchanged their positions and could be thrown into appropriate activity for the crossed relations of the muscles. This principle of nerve-crossing found a practical application in many cases of paralysis of a muscle or group of muscles supplied by a particular nerve. A portion of the nerve below the lesion could be grafted on to a neighbouring normal nerve with probability of restoration of the function of the paralysed muscles. Photographs were shown of a case of facial spasm which he had relieved by dividing the facial nerve and grafting its distal end on to the spinal accessory. The result had been return of normal voluntary movement in the face and absence of spasm. But movements of the face tended to occur as an accompaniment of certain movements of the arm.

Prof. Waymouth Reid, F.R.S. (Dundee), discussed the question "Can solutions of Native Proteids exert Osmotic Pressure?" Of the two methods of testing this question, namely, cryoscopy and direct measurement against a membrane impermeable to proteid, the latter alone is likely to lead to a satisfactory answer. Against the cryoscopic method would be the high molecular weight and errors due to traces of salts not fully eliminable by observation on solution of the ash. The method of direct measurement is liable to error in the possibility of presence of a contamination (not salts) which, like proteid, cannot pass the membrane, and so if in solution exerting osmotic pressure. A true finding on the point is only likely to be reached by working with "solutions" of pure proteid. The experiments of Starling with blood serum led to variable results, the osmotic pressure for the 1 per cent. concentration of the proteids in their native fluid being given as from 2·97 to 5·29 mm. Hg. at room temperatures. These experiments prove that substances exist in solution in serum to which a gelatine membrane is impermeable, but they do not prove that the osmotic pressure observed is due to the proteid constituent either in part or *in toto*. The proteid might be inactive *quâ* production of osmotic pressure, and some other constituent of serum in solution might be responsible. A well-dialysed solution of once crystallised horse serum-albumin gave osmotic pressure on a formalised gelatine membrane against distilled water in a rocking osmometer, a pressure which after fourteen days had settled to 15·5 mm. Hg. for the 1 per cent. concentration of proteid. The pressure remained constant at this level for another six days (*i.e.* until the twenty-first day of experiment), after which the observation was stopped. Had the experiment been stopped six days after the start the estimate of osmotic pressure would have been 28 mm. of mercury for the 1 per cent. concentration of proteid, a level at which it stood constant till the ninth day. The membrane was proved impermeable to proteid by the ordinary tests, but the preparation of serum-albumin was also proved impure, for it held more than 17 per cent. of nitrogen.

Ovalbumin is so readily crystallised and recrystallised by Hopkins' modification of the Hofmeister method that we can probably assure ourselves of the purity of this proteid better than of that of any other from an animal source.

With "solutions" of recrystallised and well-washed ovalbumin (15·41 per cent. of nitrogen) no pressure can be got on a natural or formalised gelatine membrane, proved (at the end of the experiment) impermeable to the proteid.

Dilute "white of egg" in contrast gives a lasting pressure against its filtrate through a gelatine filter, at similar concentration in proteid. The addition of sodic hydrate to the "solution" of ovalbumin, within the limits of appearance of alkalinity to litmus or phenolphthalein, does not affect the negative result.

Finally, a "solution" of crystallised hemp-seed globulin in sodic chloride solution put against the original salt solution gave no pressure on a gelatine membrane proved impermeable to the globulin at the end of the experiment.

If these experimental results are borne out by those still in progress, the conclusion of many will be strengthened, viz. that such so-called solutions are only suspensions, since the power to exert osmotic pressure on a suitable membrane is our most convincing test of solution in the case of a non-electrolyte.

Prof. Waymouth Reid also read a contribution to the study of ionic effects as exemplified in the small intestine. The action of salts in solution upon various vital phenomena has long been studied, but the subject is prominent just now as a result of the brilliant experiments of Prof. Loeb and his pupils.

From a general point of view his more important conclusions are:—

(1) Several different metallic ions are necessary for the exhibition of vital phenomena, and the nature of these and their optimum relative proportions vary in different tissues and classes of vital phenomena, even in one and the same animal.

(2) One can impart to a living tissue new properties by changing the quality and the relative proportions of the ions in it.

The sodium ion is the most active in starting rhythmical construction of skeletal muscle, but other ions must be present in addition, otherwise by mere excess the sodium becomes a poison.

Again, we cannot reason from the action of a given ion upon one tissue to its action on another, even if the second tissue performs functions which are superficially analogous.

Thus Lillie observed that in the larva of *Arenicola cristata* ciliary motion continued in solutions of calcium, magnesium and potassium salts which stopped the activity of the muscles of the body, while contraction of the body-muscles continued in solutions of sodium salt which stopped the motion of the cilia.

Potassium ions, so poisonous to cardiac muscle, may be beneficial to the action of other protoplasms. Loeb found that the early development of *Fundulus* embryos was favoured by potassium ions up till the formation of the heart.

In the eggs of the marine annelid *Chaetopterus*, which when unfertilised do not develop in sea-water, an artificial parthenogenesis can be started by potassium ions, and the action is ionic and not osmotic as in some parthenogeneses. Here the potassium ion acts as a specific stimulant. One would expect that if the cells of the mammalian intestine take an active part in the process of absorption a variation of the preponderating ion in the solution of the substance the absorption of which is being studied might affect the absorption of the substance by the gut wall.

In the experiments glucose was selected for study since it is normal to the intestine and capable of fairly accurate estimation, and the absorption of isotonic solutions of glucose in sodium and potassium chloride solutions were compared.

The results so far have indicated that a preponderance of the potassium ion over the sodium ion favours the uptake of glucose, about half as much again of the glucose being absorbed from solutions holding potassium chloride as from solutions of equal molecular concentration holding sodium chloride.

Unfortunately, the ionic effect can only be studied, in this case, from the cavity side of the membrane, on account of the highly poisonous action of potassium upon the heart muscle when exhibited in the circulating blood. Experiments with other ions were in progress.

Dr. Albert A. Gray (Glasgow) read a paper on some methods of preparation of the inner ear, with remarks on its function. He showed a new method of preparing the membranous ear by first supporting the structure and then destroying the surrounding bone. From these preparations he drew inferences regarding the phenomena of giddiness and of the theories of hearing. A preparation was shown of the entire internal ear. After first embedding preparations in a firm substance the surrounding bone was decalcified by nitric acid, and the whole was rendered transparent by oil of thyme. The demonstration of the upward increase in width of the ligamentum spirale of the cochlea was a matter on which Dr. Gray especially laid stress.

Dr. Noel Paton (Edinburgh) gave on behalf of himself and Drs. Gulland and Fowler some account of experiments in examination of the asserted hæmatopoietic functions of the spleen. His previous work had shown that the spleen exerted no

detected influence upon the course of chemical digestive changes in mammals. The question remained, "Is the spleen connected with production of blood corpuscles?" The methods he and his colleagues had employed were (1) comparison of corpuscles in blood entering and leaving the spleen; (2) effect of removal of spleen on number of blood corpuscles; (3) the rate of recovery of the number of corpuscles in animals with and in animals without spleen after hæmorrhages and after hæmolytics.

The results obtained by these methods were:—(1) No difference observed in blood of splenic vein and splenic artery. Rollett's well-known statement in Stricker's "Handbuch" of the great relative increase of leucocytes in the blood of the splenic vein was therefore not confirmed. (2) Removal of the spleen (dog, rabbit, cat) produced no perceptible change in the number of corpuscles in the blood. (3) Recovery of number of corpuscles after hæmorrhage and hæmolytics proceeded as fast in the animals without spleen as in those with spleen.

Dr. W. Brodie Brodie (Glasgow) made a communication on the action of oxalates on the calcium of muscle. From a series of observations made it was argued (1) that the action of oxalates in destroying muscular irritability was only manifest when the muscle was thrown into repeated contractions; (2) that the irritability of resting muscles was not injured by oxalates; (3) that it was probable that calcium was liberated from a complex compound when the muscle entered into contraction.

Dr. W. H. R. Rivers (Cambridge) communicated the results of testing the vision of natives of Murray Island and that of a number of English people with the visual illusion known as the Müller-Lyer. This well-known illusion is one in which additional straight lines lengthen or shorten in appearance an original straight line according to the inclination of the direction toward it. By means of a slide the line could be made of the same length as a standard line. Observations were carried out on forty-two English people and thirty-eight natives of Murray Island, between New Guinea and Australia. Each person made ten trials. The standard line measured 75 millimetres; to the average English person the line compared with it appeared equal to it when of 53 millimetres length. The average Murray Islander made the line 60 millimetres, so that the illusion was less pronounced with him than with the average English observer. There was marked agreement among the Murray Island men, who were as uncultured and unskilled in the European sense as any population could be. The Murray Islanders, though they could be regarded as savages, were yet able to make these observations very well. When Dr. Rivers went out on his expedition he anticipated great difficulty in getting people of that degree of civilisation to enter into the making of such observations. He had, however, in fact found that they made them with even more attentiveness than the average Englishman could be induced to give to the test. The English individuals tested could be divided into two classes, those acquainted with the illusion, such as students of psycho-physiology, and those who were roughly acquainted with it through the advertisements of soap manufacturers, &c. It was interesting that the results obtained from both these classes were practically the same. The English individual when told to make the two lines equal as he saw them no doubt sometimes involuntarily corrected to some extent the tendency developed in the illusion. The Murray Islanders gave more consistent results than the Europeans. This greater consistence may have been due to the total ignorance by the Islanders and their thus remaining uninfluenced by speculation founded on knowledge of the illusion. Prof. McKendrick, in thanking Dr. Rivers for his valuable communication, urged the great interest, both practical and theoretical, of the labour of psycho-physiologists. At present the labour was chiefly the accumulation of facts many of which as yet were difficult to coordinate into general laws. It was exceedingly important that the subject should be seriously taken up in this country. In the American schools a great deal of useful progress was being made.

On Tuesday, September 17, Dr. C. S. Myers (Cambridge) communicated the results of a series of observations made with Galton's whistle upon the hearing of the Murray Islanders and some inhabitants of Buchan, Aberdeenshire. The result showed that the Murray Islanders could not at any age hear such high-pitched notes as the people of Buchan. The latter had from childhood upward a finer perception for high-pitched notes than the former.

Prof. Marcus Hartog demonstrated a model showing the mechanism of the frog's tongue.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

OXFORD.—The 230th meeting of the Junior Scientific Club was held on November 29. Dr. Gustav Mann (New College) read a paper on the theory of dyeing and staining, and Mr. D. A. Gilchrist one on agricultural experiments at Reading and in Canada.

Mr. A. J. Jenkinson, of Hertford College, has been elected to the John Locke scholarship in mental philosophy.

Mr. G. W. S. Farmer, of Balliol College, has been appointed Litchfield lecturer in clinical surgery for two years.

CAMBRIDGE.—The Allen scholarship for research in medicine, mathematics, physics and chemistry, biology and geology, or moral science, will be awarded in the ensuing Lent Term. The emolument of the student is 250*l*. for one year. Any graduate of the University is eligible, provided he is not more than twenty-eight years of age on January 8, 1902. Candidates must send their names, with a definite statement of the course of research they propose to undertake, to the Vice-Chancellor by February 1, 1902.

THE annual prize distribution and members' and students' conversazione of the Northampton Institute, Clerkenwell, will be held to-morrow, December 6. The Marquis of Northampton will distribute the prizes.

MR. HERBERT J. FLEURE, a student of Prof. Ainsworth Davis at University College, Aberystwyth, has been elected a Fellow of the University of Wales. The Fellowship is one of the highest distinctions of the University, and its conferment for the first time upon a student who has been engaged in zoological research is of noteworthy interest.

THE influence which the universities in Germany have had upon industrial progress was emphasised by Prof. Senier in an address entitled "Bonn on the Rhine: Pages from its History and Stray Thoughts on Education" (Dublin: Edward Ponsonby), recently delivered at Queen's College, Galway. It is sometimes thought that the advance of German industry has been due to technical schools, but Prof. Senier remarks: "Probably it would be more correct to say that the technical schools are due to the rise of industries. No doubt technical schools have had and will have some effect in assisting manufactures. But the main source of those industries depending upon science has always been and must always be science itself, the outcome of university work." In this opinion Prof. Senier follows what the readers of NATURE have been familiar with during the last twenty years.

A GIFT of 5000*l*. has been offered to the University of St. Andrews by Dr. T. Purdie, professor of chemistry in the University, for the purpose of building and equipping a small chemical research department. In his letter to Principal Donaldson intimating the gift, Prof. Purdie says that their universities are very poorly provided for research when compared with those of foreign countries, and that scientific industries suffer in consequence. At St. Andrews in particular, except in zoology, there is no special provision in any of the science departments for original investigation. He therefore trusts that the University Court will accept his gift for the purpose mentioned, and that means may soon be found to equip other science departments. The success of the scheme, however, presupposes that scholarships will be available to encourage students to undertake post-graduate work, and also that an annual grant of money will be provided for laboratory expenses. He makes it a condition of his gift that the Carnegie trustees shall regard the scheme with favour and signify their willingness to help in the direction indicated. The gift is made in memory of his late uncle, Mr. Thomas Purdie, of Castlecliffe.

SO many subjects are dealt with in the latest report of the U.S. Commissioner of Education that it is impossible to do more than mention a few matters considered in this volume, the contents of which occupy as many as 1280 pages. An account is given of the origin, growth, influence and relation to the public of the great secondary schools of England. The change in the character of secondary instruction in some schools from the old exclusively classical system to one related to modern requirements is pointed out in connection with its cause—the demands of commerce and industry. The national conservatism appears in the slow rate of change and the spirit in which science is even now accepted in the secondary school

curriculum. A detailed table of the schools of Berlin is given in the report, and it shows a surprising variety of educational agencies in the German capital. The table reveals the fact that Berlin has 103 secondary schools and 306 elementary schools. It is evident from the table that the city is making great efforts to assist the industrial education of its youth. Another article in the report contains a statement of the number of students in higher institutions of learning in fifteen prominent countries. The tables show, first, that the Teutonic nations—Germany, Austria, Switzerland, Belgium and the Netherlands—are in the front rank, not only in the number of students in higher institutions, but also in the ratio of increase. Second, that the percentage of increase in students of technical institutions, such as polytechnic institutions, agricultural and mining schools, is everywhere larger during the year 1898-99 than in those of universities and colleges. We note, for instance, that the attendance in universities in Germany increased 6·5 per cent., but that of technical institutions increased 8·2 per cent. In Austria the increase in universities was 4 per cent.; in technical institutions it was 7·8 per cent. In Russia the increase in universities was 1·2 per cent.; in technical institutions it was 7·7 per cent. Such figures are significant, inasmuch as they indicate that the industries of Europe and America are claiming more thorough and more special preparation than formerly.

SCIENTIFIC SERIAL.

Transactions of the American Mathematical Society, vol. ii. No. 4, October.—Geometry of a simultaneous system of two linear homogeneous differential equations of the second order, by E. J. Wilczynski, is a continuation of a previous paper (in No. 1 of the present volume), entitled "Invariants of Systems of Linear Differential Equations." In this some new theorems are deduced, but it is mainly concerned with geometrical interpretations. The author confines himself to the special case of the equations

$$y'' + p_{11}y' + p_{12}z' + q_{11}y + q_{12}z = 0,$$
$$z'' + p_{21}y' + p_{22}z' + q_{21}y + q_{22}z = 0,$$

the independent variable being x. The consideration of configurations in hyperspace is avoided. The treatment is connected with the work of Halphen and Fano upon the single linear differential equation (*cf. Math. Annal.* vol. liii.).—The chief result of Dr. L. E. Dickson's theory of linear groups in an arbitrary field is the exhibition of four infinite systems of groups of transformations which are simple groups in every domain of rationality. For the case of the field of all complex numbers these groups are the simple continuous groups of Lie. The chief results in a finite field are given in the author's "Linear Groups" (Teubner, Leipzig, 1901). Corresponding to the isolated group of 14 parameters, there exists in the Galois field of order p^n a new system of simple groups of order $p^{6n}(p^{6n}-1)(p^{2n}-1)$.—On certain aggregates of determinant minors, by W. H. Metzler. In 1888 Dr. T. Muir showed (*Proc.* Roy. Soc. Edin., pp. 99–105) that a linear rotation exists between certain minors of a centro-symmetric determinant similar to Kronecker's relation between the minors of an axi-symmetric determinant; and in 1900 he gave two theorems connecting the minors of any determinant, the first of which reduces to Kronecker's relation and the second of which reduces to his 1888 relation.—Prof. Metzler extends these relations and gives a series of types of linear relations between the minors of a centro-symmetric determinant. The present memoir gives the number of relations of each type.—Two papers by A. Pringsheim are (1) ueber die anwendung der Cauchy'schen multiplications regel auf bedingt convergente oder divergente reihen, and (2) ueber den Goursat'schen beweis des Cauchy'schen integralsatzes. These, as well as several of the other papers in the number before us, were communicated to the Ithaca meeting of the Society (August 19).—New proof of a theorem of Osgood's in the calculus of variations, by Oskar Bolza, is a simple one of the important characteristic property of a strong minimum in the calculus.—On certain pairs of transcendental functions whose roots separate each other, by the same author, proves the theorem, if, in a certain interval, p, q, ϕ_2, ϕ_1, ψ_2, ψ, are continuous real functions of the real variable x, and if the last four of these functions have continuous derivatives, then, y being a solution not identically zero of the differential equation $y'' + py' + qy = 0$, the roots of the functions $\phi_2y' - \phi_1y$, $\psi_2y' - \psi_1y$ will separate each other if no one of the three functions $\phi_1\psi_2 - \phi_2\psi_1$, $\phi_1'\phi_2 - \phi_1\phi_2' + \phi_1^2 + p\phi_2\phi_1 + q\phi_2^2$, $\psi_1'\psi_2 - \psi_1\psi_2' + \psi_1^2 + p\psi_2\psi_1 + q\psi_2^2$ vanishes at any point of the interval in question. Certain extensions of the above theorem are also established.—On the system of a binary cubic and quadratic and the reduction of hyperelliptic integrals of genus two to elliptic integrals by a transformation of the fourth order, by J. H. Macdonald, effects the reduction by a special involution of order four containing a form which is the square of a quadratic. Reference is made to Prof. Bolza's inaugural dissertation (Göttingen, 1886). The sections discuss theorems on the biquadratic involution having a complete square, the system of a cubic and two linear forms and their conjugate system, the system of a cubic and quadratic and their conjugate system, certain involutions, and miscellaneous results on biquadratic involutions containing a complete square.—On the theory of improper definite integrals, by E. H. Moore. In the paper the author discusses the types connected with the names of Cauchy, Riemann, du Bois-Reymond, Dini, Schoenflies, Harnack and Jordan, Hölder, and de la Vallée-Poussin. Prof. Moore himself defines a system of types, which differ according to the way in which the integral depends (by definition) upon the sets of points of singularity of the integrand function with respect to definite integration.—On the convergence and character of the continued fraction $\frac{a_1z}{1} + \frac{a_2z}{1} + \frac{a_3z}{1} + \ldots$, by E. B. Van Vleck, is a portion of the paper, contributed by the author to the August meeting of the Society, on the convergence of the continued fraction of Gauss. In this portion the theorem established is—if, in such a fraction, the greatest modulus of any point of condensation of the sequence a_1, a_2, a_3, ... is k, then within a circle of radius $1/4k$, described about the origin as centre, the continued fraction will represent an analytic function, and the only singularities of the function contained within the circle will be poles. In any region excluding these poles and lying in the interior of the circle the convergence will be uniform.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, November 21.—"The Pear-shaped Figure of Equilibrium of a Rotating Mass of Liquid." By Prof. G. H. Darwin, F.R.S.

"Sur la Stabilité de l'Équilibre des Figures Pyriformes affectées par une Masse Fluide en Rotation." By H. Poincaré, For. Mem. R.S.

"On the Process of Hair Turning White." By E. Metchnikoff, For. Mem. R.S.

Although the fact of hair turning white is a most familiar one, its mechanism has not as yet been unveiled. The authors of works on hair and dermatology acknowledge their ignorance concerning this subject.

Having undertaken a study on atrophic processes, and especially on senile atrophy, my attention has been called to the atrophy of hair pigment so frequent in old people.

Observations on grey hair, or on hair beginning to turn grey, showed me that the atrophy of its pigment is due to the intervention of phagocytes of the hair.

These cells have a single nucleus and their very different aspect one from another is due to numerous amœboid prolongations of their protoplasm. They are derived from the medullary part of the hair and make their way out into its cortical layer, where they absorb the pigment granules, which they then remove from the hair.

If we consider hair, one part of which is already white and the other still pigmented, we find a great many of these phagocytes. They are supplied with greatly developed prolongations and become insinuated between the keratic cells of the peripheral layer.

In absolutely white hair the phagocytes filled with pigment become more and more scarce, and most frequently completely disappear.

It is thus indubitable that the phagocytes of the hairs swallow up the granular pigment of the cortical layer and transfer it elsewhere, the result being the complete whitening of such hair. On observing the root of hair beginning to whiten, we often find a great many phagocytes filled with pigment.

The whitening of the hair of old dogs proceeds by the same mechanism. We equally find here a great number of phagocytes

supplied with numerous prolongations and stuffed with pigment granules.

The part played by phagocytes in the whitening of hair explains many phenomena observed long ago, but not as yet sufficiently understood. Thus, hair turning white in a single night, or in a few days, may be explained by the increased activity of hair phagocytes thus enabled to transfer the pigment in so short a time.

The mechanism of the whitening of hair through the agency of phagocytes allows this case of atrophy to be classed under the general laws of atrophy of solid parts of the organism.

"On the Inheritance of the Mental Characters in Man." By Karl Pearson, F.R.S.

(1) Mr. Francis Galton, in his "Natural Inheritance," first, I believe, endeavoured to give a *quantitative* appreciation of the inheritance of the mental characters in man. Mr. Galton's data were not very copious, and in default of a method of dealing quantitatively with characters not capable of exact scaling, it was not possible to deduce absolutely conclusive results. On November 19, 1899, a paper was read to the Royal Society showing how the inheritance of characters not capable of exact quantitative measurement might be deduced. I purpose in this notice to give only a few results from some very elaborate observations which have been made in the course of the last few years and reduced by the processes of that paper.

(2) The material was collected in two separate ways. In the first series—the Family Measurement Series—only physical characters were observed. This series was started six years ago, and upwards of 1100 families, father, mother, and not more than two sons and two daughters, were measured. The series was closed two years ago, and last year Dr. Alice Lee completed the reduction of this very large mass of material.

My second series is still more extensive; but it relates only to collateral—fraternal—heredity. It aims at observing a wide range of both physical and mental characters in pairs of school children. I have received most kindly aid from a great number of masters and mistresses in public schools, high schools, secondary and primary schools of all classes. This will be very fully acknowledged in the final publication of the results. But although the work has been in progress for three years, we have still only material enough to draw conclusions in the case of pairs of brothers, of whom more than 1000 cases have been observed.

(3) Only three of the physical measurements of this extensive series have yet been reduced, and the sister-sister and sister-brother observations will have to be carried on for another year or two before they are sufficiently numerous to be dealt with. The whole material will then require two or three years for tabulation and calculation. But as the problem of the inheritance of the mental characters and their correlation with the physical was occupying our attention in another field, the indefatigable Dr. Lee undertook the tabulation and calculation of the coefficients of heredity in the case of seven mental and three physical characters for pairs of brothers. The number of pairs dealt with in each case was 800 to 1000. The method adopted was that of the memoir on "The Inheritance of Characters not capable of Exact Quantitative Measurement."[1] Thus, under the heading *Conscientiousness* were two divisions, Keen and Dull, and the teacher might place a cross on either of these or on the dividing line. Similar divisions occurred in the other categories, except that *Intelligence* was given six and *Temper* three subdivisions, &c. The sole object in the present preliminary notice is to draw attention to the following results:—

Coefficients of Collateral Heredity.

Correlation of Pairs of Brothers.

Physical Characters. (Family Measurements.)		*Mental Characters.* (School Observations.)	
Stature	0·5107	Intelligence	0·4559
Forearm	0·4912	Vivacity	0·4702
Span	0·5494	Conscientiousness	0·5929
Eye-colour	0·5169	Popularity	0·5044
(School Observations.)		Temper	0·5068
Cephalic index	0·4861	Self-consciousness	0·5915
Hair-colour	0·5452	Shyness	0·5281
Health	0·5203		
Mean	0·5171	Mean	0·5214

The physical characters were measured or observed on two entirely different groups of individuals—in the one case adults, in the other children were examined. The means for both series are almost identical (·5170 and ·5172). Dealing with the means for physical and mental characters their likeness forces us to the perfectly definite conclusion: *That the mental characters in man are inherited in precisely the same manner as the physical.* Our mental and moral nature is, quite as much as our physical nature, the outcome of hereditary factors.

[1] *Phil. Trans.* A vol. cxcv. pp. 79–150.

Entomological Society, November 6.—The Rev. Canon Fowler, president, in the chair.—The Rev. F. D. Morice exhibited two imperfectly developed females of *Osmia leucomelana* found dead in a *rubus* stem at Woking with their cases.—Mr. C. P. Pickett exhibited a series of aberrations of *Colias hyale* taken at Folkestone during August 1900–1.—Mr. F. B. Jennings exhibited a specimen of *Trachyphloeus myrmecophilus*, Seidl., taken at Hastings in September last, retaining intact the deciduous "false mandibles," with the aid of which the imago of the species of this and certain other genera of weevils is said to work its way to the surface after emerging from the pupa underground. These mandibles are usually shed as soon as the imago begins its life above ground, as there is no further use for them.—Mr. W. J. Kaye exhibited a collection of butterflies made by him in Trinidad, with several hitherto undescribed species. He said that the probable total rhopalocerous fauna was about 250 species, the island—about the size of Somersetshire—being thus remarkably rich in butterflies. The number of the species in the families exhibited were Nymphalidæ 34, Satyridæ 13, Papilionidæ 6, Pieridæ 31, Erycinidæ 29, Lycænidæ 27, Hesperiidæ 62—nearly all taken within three or four miles of Port of Spain. The series of *Heliconius telchinia* and *Tithorea megara*, var. *flavescens*, were particularly fine, showing the yellow coloration only found in Trinidad and the coast of Venezuela immediately opposite. A long series of *Papilio xeuxis*, and *Papilio alyattus*, many of them bred from the same parent ♀, show that these two are in reality identical species. The number of Erycinidæ in Trinidad compared with the poverty of the same species in other West Indian islands indicates the different origin of its fauna, and suggests affinity with the mainland of Venezuela, which at the nearest point is but seven miles distant.—Dr. Chapman exhibited specimens of *Parnassius apollo* taken last July in Castile and Aragon (Spain), as well as a number of specimens of both *P. apollo* and *P. delius*, chiefly Swiss and French, taken by himself, Mr. Tutt, Mr. A. H. Jones (at Digne), and Mr. Rowland-Brown (at Susa, N. Italy), for comparison with the Spanish specimens and to illustrate the extent to which the races of these species approach each other in western Europe.—Mr. G. C. Bignell sent for discussion a specimen of *Sphecophaga vesparum*, Curt., and the cocoon from which it had been bred.—Mr. Gilbert J. Arrow communicated a paper upon the genus Hyliota, with descriptions of new forms and a list of described species, and Mr. W. L. Distant, contributions to a knowledge of the Rhynchota.

Royal Meteorological Society, November 20.—Mr. W. H. Dines, president, in the chair.—A paper by Mr. A. Lawrence Rotch on the exploration of the atmosphere at sea by means of kites was read by the secretary. The author has for some years past devoted his attention to the use of kites to obtain meteorological observations at the Blue Hill Observatory, Mass., U.S.A., and he has successfully carried on the work of exploring the air there to a height of three miles by several hundred kite flights executed in varied weather conditions whenever the velocity of the wind exceeded twelve miles an hour. Certain types of weather, however, such as anti-cyclones, accompanied by light winds, can rarely be studied. Mr. Rotch now proposes the employment of kites carrying meteorographs on steamships, especially on vessels cruising in tropical oceans. He has himself demonstrated the practicability of this scheme, as on August 22 last he raised a kite to an elevation of half a mile from a tow-boat in Massachusetts Bay, when the velocity of the wind at sea-level varied between six and ten miles an hour. At the end of the same month, when crossing the North Atlantic from Boston to Liverpool on the steamship *Commonwealth*, he was able to raise kites carrying a meteorograph to an altitude of 1600 feet on five days out of the eight. The chief feature of these records was the rapid change of temperature with height.—A paper by Prof. J. Milne, F.R.S., on meteorological phenomena in relation to changes in the vertical, was also read by the secretary. When resident in Japan some years ago the author carried on numerous observations by seismographs for ascertaining changes in the vertical, and found that

the more important displacements of the horizontal pendulums are of three types, viz. intermediate, long and short period wanderings. During the last five years Prof. Milne has had continuous photographic records of a horizontal pendulum at his residence at Shide, Isle of Wight, and he now makes a comparison of these records with the weather conditions prevailing during the first six months of 1901. He says that assuming that a locality can be chosen where the diurnal wave and effects due to rain and desiccation are small, which his observations indicate as possible, records of what appear to be the effects due to barometrical gradients may be obtained. When these are large and appear suddenly, the movements of the pendulum may be marked. At Shide the westerly displacement of a pendulum has, for several years past, been regarded as indicating the approach of bad weather.

Anthropological Institute, November 12.—Mr. W. Gowland, vice-president, in the chair.—Mr. R. Shelford exhibited (1) a series of slides of natives of Sarawak, and (2) a collection of gold jewellery found in Borneo, lent by H.H. the Rajah of Sarawak.—Mr. Shelford read a paper entitled "A Provisional Classification of the Swords of the Natives of Sarawak."—Mr. J. Gray exhibited a craniometer for measuring the height of the head.

November 26.—Mr. C. H. Read, ex-president, in the chair.—Mr. E. Willett exhibited a number of Palæolithic implements from Savernake.—Mr. N. W. Thomas exhibited a collection of "totem-stones" collected by the Hon. Auberon Herbert. The exhibit was discussed by Mr. Balfour and Mr. Read.—Mr. R. F. Gatty read a paper on dwarf flints from the sand mounds of Scunthorpe, illustrated by a number of specimens.

MANCHESTER.

Literary and Philosophical Society, November 26.—Mr. Charles Bailey, president, in the chair.—Prof. H. B. Dixon mentioned that Mr. H. Brereton Baker had succeeded in making a mixture of hydrogen and oxygen so pure that it would not explode when the vessel containing it was raised to a red heat or when a silver wire was melted in it. In one case some water was gradually formed, so that the explosion of the gases would seem to depend on the presence of some impurity other than steam itself.—Prof. F. E. Weiss exhibited two dwarf Japanese trees which have been purchased for the Manchester Museum. They were *Pinus parvifolia* and *Thuja obtusa* (the Japanese cypress), both natives of Northern Japan, where they grow at very great altitudes and are naturally of small growth. The trees exhibited, which were thirty and forty years old respectively, were only six to nine inches in height, these dwarf forms being obtained by a system of starving and pruning back the plants and by contortions of the stem and branches which retard the nutritive processes.—Mr. J. E. Petavel read a paper entitled "On the Measurement of High Explosive Pressures." After a short review of the various methods and instruments used by Rumford, Bunsen and Rodman in the first half of the nineteenth century, and by Noble, Berthelot, Vieille, Le Chatelier and Mallard in recent years, the author went on to describe a new form of recording gauge, which is, in principle, not far removed from the ordinary crusher gauge. The short copper cylinder is replaced by a hollow steel cylinder one inch in diameter and five inches long, the relative cross-sectional areas of the piston and cylinder being calculated so that the strains are well below the elastic limit of the material. The actual motion of the piston is thus limited to one or two thousandths of an inch, and a very high time period is obtained. The motion of the piston is transmitted to a mirror, the movement of which is photographically recorded on a revolving drum. The amplitude of the records thus obtained is about 1″; they can be measured to an accuracy of about one-thousandth of an inch. A number of records referring to mixtures of coal gas and air or oxygen and hydrogen were shown, the pressures ranging up to twelve thousand pounds per square inch.

PARIS.

Academy of Sciences, November 25.—M. Fouqué in the chair.—On the absence of action of a magnetic field upon a mass of air which is the seat of a current of displacement, by M. R. Blondlot. It has been shown in a previous paper that if a mass of air is moved in a magnetic field normally to the lines of force no electric displacement results in this mass of air. From this it follows that a mass of air which is the seat of an electric displacement should undergo no action in a magnetic field. If the principle of action and reaction is applied to this proposition it leads to the conclusion that a current of displacement in the air exerts no magnetic action, and consequently that the charging current of a condenser is an open current from the magnetic point of view. This is in direct opposition to one of the fundamental principles of Maxwell's theory, and choice has to be made between renouncing this theory or the principle of action and reaction.—On ibogine, the active principle of a plant of the genus Tabernæmontana, coming from the Congo, by MM. A. Haller and Ed. Heckel. In the Congo and neighbouring countries several species of plants possessing analeptic and stimulating properties are used by the natives under the name of Iboga. These peculiar properties have been assigned by MM. Dybowski and Landrin to a special glucoside, by M. Schlagdenhaufen to a new alkaloid. The specimens of this plant shown in the Colonial Exhibition of 1900 have been utilised for the extraction of this substance. The amount of material was small, but it is clear that the substance is a true alkaloid and not a glucoside, and the formula $C_{26}H_{32}N_2O_2$ is provisionally assigned to it. The alkaloid itself has been obtained in the form of white crystals, but all the salts obtained up to the present are amorphous.—The mummified birds of ancient Egypt, by MM. Lortet and Gaillard. The specimens examined differ greatly in their states of preservation, some being so perfectly preserved that a simple examination of the feathers was sufficient for the identification whilst in others the skeleton was the only possible guide. Some thirty-eight species were identified, the greater number of these not having been found before in the mummy state.—The *Okapia Johnstoni*, a new mammal allied to the giraffe discovered in Central Africa, by Prof. E. Ray Lankester. A drawing and description of a new mammal discovered by Sir H. Johnstone in the Semliki Forest on the borders of the Congo Free State and Uganda. The skin bears no resemblance to that of the giraffe, but its relationship to this animal is absolutely demonstrated by its skull. It may possibly be the living representative of the Miocene genus Helladotherium.—Remarks by M. Albert Gaudry on the preceding paper. M. Gaudry presented at the same time a restored head of Helladotherium.—M. Yves Delage was elected a member in the section of anatomy and zoology in the place of the late M. de Lacaze-Duthiers; M. Gouy, a member in the section of physics in the place of the late M. Raoult.—On the number of roots common to several equations, by M. A. Davidoglou.—The determination of some coefficients of self-induction, by Mr. G. A. Hemsalech. In a previous paper on the spectra of electric sparks the coefficients of self-induction were calculated from the dimensions of the coils. It has now been recognised that these were too great, and hence they have been redetermined experimentally. The most advantageous values for spark-spectrum observations are now given as ·00286 Henry for cobalt, zinc, magnesium and aluminium; ·00689 Henry for manganese aad silver; ·0254 Henry for antimony; and ·0419 Henry for iron, nickel, cadmium, tin, lead, bismuth and copper.—On the regular distribution of the magnetic inclination and declination in France up to January 1, 1896, by M. E. Mathias.—On the application of the clear chamber of Govi to the construction of a comparator for end standards, by M. A. Lafay. The arrangement described allows the difference in length between a standard and its copy to be expressed as the algebraic sum of the displacements of two plane mirrors mounted on micrometer screws. It has the advantage over the ordinary methods in avoiding all deformations due to the actual contacts of the ends of the standards with the holders used in the ordinary instruments.—On the combinations of aluminium chloride with the alkaline chlorides, by M. E. Baud. It is shown by thermochemical studies that the compounds $Al_2Cl_6.3NaCl$ and $Al_2Cl_6.3KCl$ exist, and very probably also $Al_2Cl_6.6NaCl$ and $Al_2Cl_6.6KCl$.—On the preparation of barium, by M. Guntz (see p. 112).—On a new volatile salt of beryllium, by MM. G. Urbain and H. Lacombe. A description of the preparation and properties of a basic acetate of beryllium. It boils under the ordinary pressure without any sign of decomposition at a temperature of 330–331° C., and its vapour density at the temperature of boiling mercury was found to be 13°·9, which is in accordance with the atomic weight Be = 9.—The action of fuming sulphuric acid upon acetaldehyde and propaldehyde and acetone, by M. Marcel Delépine.—On the electrolytic preparation of the halogen derivatives of acetone, by M. A. Richard. The electrolysis of mixtures of acetone with hydrochloric and hydrobromic acids gives monochloroacetone and monobromo-

acetone respectively. In the present paper the conditions necessary for a maximum yield of the halogen derivative are determined.—On the transformation by a new reaction of two xanthydrols into xanthenes, by M. R. Fosse.—The etherification of phosphorous acid by glycerol and glycol, by M. P. Carré.—On the reserve store of carbohydrates in the seed of *Aucuba japonica*, by M. G. Champenois. The seed of this plant contains a large quantity of cane-sugar accompanied by a glucoside. Besides the soluble compounds the seed contains as constituents of its hard albumen a galactane, a mannane and a pentane which give on hydrolysis galactose, mannose and a pentose which appears to be arabinose.—On an experiment of M. Berthelot relating to the transformation of glycerol into sugar by the testicular tissue, by M. Gabriel Bertrand. It is found that the action of the sorbose bacterium upon glycerol, which up to the present has been regarded as specific, is really an action common to different organisms.—Experiments on chlorophyll assimilation, by M. M. Harroy. The author has repeated the experiments of M. Friedel, but has not been able to confirm them, and he regards it as premature to state as a fact that the chlorophyllian synthesis may take place outside the vegetable organism and without the intervention of living matter.—Researches on the law of action of sucrase, by M. Victor Henri. The speed of inversion of saccharose by any acid is at any instant proportional to the quantity of saccharose present in the solution, from which is derived the well-known formula giving the relation between the time and the quantity present $k = 1/t \log a/a - x$. It is found that the inversion of sugar by sucrase takes place more rapidly than corresponds to this law, and a new formula is derived which expresses the experimental results better: $2k_1 = 1/t \log a + x/a - x$.—The cell of Sertoli and the formation of spermatozoids in the sparrow, by M. Gustave Loisel.—Some new geological observations in the Belledonne chain, by M. Pierre Termier.—A graphical method permitting the study of the circumstances of the course of a steerable aërostat, by the examination of the projection of its trajectory upon the earth, by M. J. Armengaud, jun.—The increase of the number of red corpuscles in the blood during a balloon ascent, by M. J. Gaule. It is shown that there is a true formation of red globules on arriving suddenly at a high altitude, the phenomena taking place with great rapidity.—The scientific treatment of deafness, by M. Marage.

DIARY OF SOCIETIES.

THURSDAY, DECEMBER 5.

ROYAL SOCIETY, at 4.30.—On the Spontaneous Ionisation of Gases: C. T. R. Wilson, F.R.S.—In title only: Notes on Quantitative Spectra of Beryllium: Prof. W. N. Hartley, F.R.S.—Notes on the Development of *Paludina vivipara*, with Special Reference to the Urinogenital Organs and Theories of Gasteropod Torsion. (Preliminary Note): Miss I. M. Drummond.—In title only: Preliminary Account of the Prothallium of *Phylloglossum*: Prof. A. P. W. Thomas.

SOCIETY OF ARTS, at 4.30.—The New Trade Route to Persia by Nushk and Seistan: Edward Penton.

LINNEAN SOCIETY, at 8.—On the Foraminifera collected round the Funafuti Atoll from Shallow and Moderately Deep Water, with Notes on New Species from the Sands of the Reef Slope: F. Chapman.—Protoplasmic Connections in the Lichens: Dr. J. H. Salter.—Exhibition: Ten Abnormal Sacra of the Frog: Dr. A. G. Ridewood.

CHEMICAL SOCIETY, at 8.—Influence of Substitution on the Formation of Diazoamines and Amino-azo-compounds: G. T. Morgan.—The Determination of Available Plant Food in Soils by the Use of Dilute Solvents: A. D. Hall and F. J. Plymen.—Some New Derivatives of Gallic Acid: F. B. Power and F. Shedden.

RÖNTGEN SOCIETY, at 8.30.—Bullets and their Billets: Experiences with X-Rays in South Africa: J. Hall Edwards.

FRIDAY, DECEMBER 6.

GEOLOGISTS' ASSOCIATION, at 8.—Notes on a Recent Visit to Egypt: Dr. C. W. Andrews.

INSTITUTION OF CIVIL ENGINEERS, at 8.—Gas-Engine Construction: R. W. A. Brewer.

MONDAY, DECEMBER 9.

SOCIETY OF ARTS, at 8.—The Chemistry of Confectioners Materials and Processes: William Jago.

ROYAL GEOGRAPHICAL SOCIETY, at 8.30.

IMPERIAL INSTITUTE, at 8.30.—The Maroons of Jamaica: H. T. Thomas.

VICTORIA INSTITUTE, at 4.30.—The Preparation of the Earth for Man's Abode: Prof. J. Logan Lobley.

TUESDAY, DECEMBER 10.

INSTITUTION OF CIVIL ENGINEERS, at 8.—*Paper to be further discussed*: Train-Resistance: John A. F. Aspinall.—*Paper to be read*: Motive-Power from Blast-Furnace Gases: Bryan Donkin.

WEDNESDAY, DECEMBER 11.

SOCIETY OF ARTS, at 8.—Aluminium: Prof. Ernest Wilson.

THURSDAY, DECEMBER 12.

ROYAL SOCIETY, at 4.30.

MATHEMATICAL SOCIETY, at 5.30.—Flexure of a Circular Plate: J. H. Michell.—Non-uniform Convergence, and the Integration of Series: Dr. Hobson, F.R.S.

INSTITUTION OF ELECTRICAL ENGINEERS, at 8.—The Physical Properties of certain Aluminium Alloys and some Notes on Aluminium Conductors: Prof. E. Wilson (conclusion of discussion).—Some Principles underlying the Profitable Sale of Electricity: Arthur Wright.

CHEMICAL SOCIETY, at 8.—Extraordinary General Meeting.

FRIDAY DECEMBER 13.

PHYSICAL SOCIETY, at 5.—On Circular Filaments and Circular Magnetic Shells equivalent to Circular Coils, and on the Equivalent Radius of a Coil: Prof. Thomas R. Lyle.—Air Pressures used in playing Brass Instruments: Dr. Barton and S. C. Laws.—A New Hygrometric Method: E. B. H. Wade.

ROYAL ASTRONOMICAL SOCIETY, at 5.

MALACOLOGICAL SOCIETY, at 8.

EPIDEMIOLOGICAL SOCIETY, at 8.30.—Dysentery in Asylums: Dr. Mott, F.R.S.

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THURSDAY, DECEMBER 12, 1901.

THE BACTERIAL PURIFICATION OF SEWAGE.

Sewage and the Bacterial Purification of Sewage. By Dr. S. Rideal. Pp. iii + 308. (London: Sanitary Publishing Co., 1901.) Price 14*s.* net.

THE practicability of effecting the purification of town sewage on the large scale by bacterial agency has now been abundantly proved. The process has passed beyond the experimental stage, and must now be acknowledged as the only method which can convert the putrescible matter of sewage on the large scale into inoffensive and harmless substances. Accordingly all trustworthy information respecting the results which have been arrived at from the lengthy experimental trials, and from the application of these results on the large scale, will be welcome to public sanitary authorities, and perhaps even still more acceptable to the professional advisers of these bodies. The treatise under review has been written by one who has carefully watched the progress, and who has had a long and varied experience, of bacterial treatment. The book is, therefore, undoubtedly worthy of careful perusal and consideration by those who are responsible for disposing of the sewage from houses, villages or towns.

The author covers a wide ground. He treats of the general character of sewage, and gives an historical sketch of the processes which have been resorted to for disposing of it. He also enters fully into the modern methods which have been recommended for the chemical examination of sewage and of sewage effluents, and states the standards of purity which have been suggested. Probably his description of the methods of collecting and examining these liquids will be of special value, since no such general description seems to be at present available. The summary of Dr. Houston's work on the identification of the bacteria present in raw sewage, a detailed account of which has appeared in the reports published by the London County Council, will also be useful, together with the account of the most important chemical changes which are brought about by bacteria. Naturally, also, some account is given of the treatment of sewage by irrigation and by chemicals, and of the "sterilisation" processes—processes which appear in the light of present knowledge of doubtful advantage, since they destroy the vast number of bacteria which effect or complete the purification of sewage, in order to make sure that a small minority of possibly injurious bacteria are disposed of.

The latter portion of the book will undoubtedly command most general attention, since here the author deals with bacterial purification. This is treated of in some detail, and the information which is given has been collected from the most trustworthy sources generally available. One can only regret that the large amount of useful matter accumulated has not been somewhat more systematically arranged and carefully summarised and compared; and, above all, that the author has not stated very clearly and emphatically the conclusions which he himself has arrived at from its careful consideration. The author has, however, apparently not been willing generally to act as assessor of the relative value of the different bacterial methods and apparatus, and due acknowledgment should be made of the time and trouble which he has expended in bringing together important information much of which, until now, has existed only in the form of scattered reports and papers. That the work which he has done in this direction is really valued is shown by the fact that a second edition of the book has been issued twelve months after the original publication; and it may be stated that the author has, as far as possible, availed himself of the opportunity which a new edition afforded him of bringing the matter up to date.

The author speaks in his preface "of the experiments on bacterial purification, which have now been carried out on a sufficiently large scale to establish the safety of embarking on the treatment of sewage on bacterial lines for even the largest centres of population." This statement proves that he is in touch with the recent experimental trials of the method at the sewage outfalls of our great towns. And it cannot be too emphatically stated that the near future is to see the adoption on the large as well as the small scale of this most rational process of "self-purification" of sewage. For after all bacterial purification is natural purification. It simply amounts to allowing the living agents of purification, which are present in the raw sewage in immense numbers, to carry out their useful function under the most favourable conditions. This adoption of natural methods must surely commend itself; and no one who looks at sewage treatment from a disinterested point of view will regret the approaching general relinquishment of artificial chemical or electrical treatment in favour of allowing natural agencies to have free course, provided only that reasonable efficiency and economy can be assured in making the change. This natural treatment may in some localities be effected on sewage farms by the development of bacteria in a suitable soil; but in most localities great advantage is obtained by substituting for the soil properly constructed bacteria beds, in which the treatment can be carried out on a smaller area and under more complete control than by means of the bacteria in the soil.

The experience and knowledge derived from several years' natural purification of sewage on the small scale in coke bacteria beds at the London and Manchester outfalls should suffice to give satisfactory assurance in these respects. After varied and continued trials it has been found independently at both these important centres that the raw sewage on its arrival at the outfalls should be roughly screened and then subjected to sedimentation without previous admixture with any chemicals. It has been shown that sedimentation may be appropriately allowed to take place in open tanks or channels in two stages. Much sand, road detritus and cellulose matter can thus be first removed, and this may be simply thrown out upon the land or dealt with in destructors without causing offence; while in the second sedimentation "sludge" consisting of fæcal and putrescible matter subsides. If the substances which are separated out by the latter sedimentation are simply left in contact with the sewage, which constantly flows over them, at least 40 per cent. of the solid sediment disappears

by bacterial action. Accordingly by the double sedimentation an average of more than 60 per cent. of the suspended solid matter or "sludge," which was present in the raw screened sewage, has been caused to disappear. This implies a very considerable diminution of cost in sludge removal and disposal; but it secures the further advantage that the still impure liquid flowing from the settling tanks has become admirably adapted for undergoing adequate purification in the bacterial coke-beds. It is noteworthy that the full power of disposing of sludge is only developed in the sludge after it has remained in contact with the flowing sewage for some considerable length of time; and it is only stale sludge which is efficient in resolving the solid insoluble matter into soluble and gaseous forms. This delay is due to the necessity of cultivating in the sludge the necessary species of bacteria, which are derived from the sewage itself.

The most efficient and rapid method of dealing with the impure liquid, which flows from the settling or so-called "septic" tanks, has been found to consist in treating it intermittently in coke-beds, which have been primed with bacteria by being placed for some weeks frequently in contact with sewage. The complete cycle of treatment in the London beds consists in filling the coke-bed, emptying it after a couple of hours, and then leaving its coke contents in contact with the interstitial air for another period of two hours. It has been found possible to repeat this cycle four times in twenty-four hours, and using beds six feet in depth to purify the settled sewage at the rate of two million gallons per acre per twenty-four hours. By this purification an effluent is obtained which is saturated with dissolved oxygen, which remains entirely inoffensive in smell for an indefinite period in an incubator at summer heat, and which, therefore, when discharged into a water-course would maintain the respiration of fish and would never render the water offensive.

Chemical examination shows that the treatment in the coke-bed has reduced the readily oxidisable dissolved matter in the settled sewage by from 60 to 70 per cent., and the whole oxidisable matter in the unsettled raw sewage by more than 90 per cent.

Bacteriological examination indicates that the effluent contains large numbers of bacteria; but the presence of these bacteria is useful in effecting inoffensively the removal of the organic substances, which still remain in the effluent, as soon as the effluent mingles with the well-aërated river water.

It is noteworthy that the sewage capacity of a newly-made coke-bed progressively decreases for a time, while its purifying power is being developed by contact with settled sewage. But the capacity ultimately becomes equal to about 30 per cent. of the whole cubic space which has been charged with coke; and, if the treatment is carried out regularly under proper supervision, this capacity fluctuates by only a few units per cent. above and below this final capacity throughout the period of many years during which the bed has as yet been worked.

The decrease of capacity to 30 per cent. is the so-called "choking" of the bed. It is due to a bacterial jelly-like growth of bacteria and zooglœa upon the coke-surfaces. If this jelly is removed and exposed to air over mercury, it will rapidly absorb oxygen from the air, and will therefore produce a partial vacuum. It appears that this growth is actually charged with oxygen during the aëration or resting of the coke-beds between the chargings with sewage liquid. The growth upon the coke-surfaces, which reduces the capacity of the bed, appears, therefore, to be the essential element of successful purification.

It is noteworthy that the growth may be unduly developed, with corresponding decrease in the sewage capacity of the bed, by over-frequently filling the bed; and by resting the bed, or reducing the number of fillings, the growth may be diminished and the capacity of the bed correspondingly increased. A great increase in the development of the jelly involves increased purification, but reduction in the amount of sewage dealt with, and *vice versâ*. Accordingly a working rate which is most advantageous on all grounds must be arrived at by trial and experience.

Careful examination of the composition of the interstitial air, even at the bottom of a coke-bed thirteen feet in depth, proves that the air is not deficient in oxygen to an extent greater than 25 per cent. of that normally present in fresh air. It appears, therefore, that although oxygen is being rapidly absorbed during the resting or aëration of the bed, the oxygen which is absorbed is rapidly replaced by natural diffusion, and mechanical aëration of the bed is unnecessary.

It has been proved that the chemical refuse which is found in the sewage of manufacturing towns seldom exerts any prejudicial action on the action of the bacteria or upon the coke-beds. In some towns, however, a preliminary treatment of the sewage has been adopted in order to remove special chemical refuse when it is present in very large quantity. This is not the case either in London or in Manchester.

One hears occasionally of so-called failures in securing bacterial purification of sewage. It is not too much to say that such failures have been due to the improper construction or working of the bacteria beds. Apparently we have still to learn of want of success when an intelligent attempt has been made under competent and experienced direction.

Although the process of natural purification of sewage must eventually become general, its adoption will undoubtedly be delayed by the lack of knowledge on the part of the majority of our public bodies and even on the part of some of their advisers. Those who wish to see the satisfactory results of experimental inquiry usefully and advantageously applied on the large scale will accordingly welcome the appearance and success of such treatises as the one which has suggested the present review.

FRANK CLOWES.

FIFTY YEARS OF BIOLOGICAL STUDY IN AUSTRIA.

Botanik und Zoologie in Oesterreich in den Jahren 1850 *bis* 1900. *Festschrift v.d.K.K. Zoologisch-Botanischen Gesellschaft in Wien.* Pp. x+620; with 38 plates and 9 cuts. (Vienna: Alfred Holder, 1901.)

THIS magnificent work illustrates in every way the jubilee of the K.K. Zoological and Botánical Society of Vienna. Twenty-two authors have collabor-

ated in its production; and its contents are as follows:—(A) A short preliminary history of the Society. (B) A descriptive history of the institutes and corporations dealing with zoology and botany, including horticulture and agriculture. (C) A history of botany in Austria during the fifty years, under the three headings of (*a*) phytogeography; (*b*) morphology, ontogeny, and systematics of cryptogams; (*c*) morphology, ontogeny, and systematics of phanerogams; (*d*) anatomy and physiology of plants.

(D) A history of zoology in Austria during the last half-century: (1) morphology and systematics, including bionomics and zoogeography; this enormous range is treated in monographs of unequal compass—Protozoa, Cœlenterata, Echinoderms and Worms are the subject of one, Tunicates and Molluscs of another, Molluscoids of a third, while the classes of Vertebrata and Arthropods, and the orders of insects among the latter, receive distinct consideration; (2) a separate article deals with animal morphology and physiology.

A bibliography of the introductory discourses ("Wrogrammaufsätze") of the educational establishments closes the text. The plates are all well-executed lithographs of (deceased) workers at our sciences, and the cuts are for the most part full-page illustrations of biological institutions. Separate indexes of singular completeness are appended, and greatly enhance the value of the book as a work of reference. Unfortunately, in the nominal index no special reference is given to the pages on which the short biographical sketches are to be found, which, as in the case of Claus and Wiesner, for example, may rise to the dignity of scientific biographies.

Thus the work contains a singularly complete record of the work done in natural history in the Empire-Kingdom practically since its inception in the forties of the late century; for previous to 1845 there existed only agricultural, horticultural and medical societies, which dealt incidentally with nature study. In that year a union of "Freunde der Naturwissenschaften" was founded in Vienna. A year later was the Vienna Academy of the Sciences founded, by the exertions of Prince Metternich, a name associated in other domains with reactionary obscurantism. The modest union formed by Haidinger, which met in the Botanic Gardens, worked quietly on, independently, through the troublous times of '48–'50; but in 1850 the primary intention of converting the occasional publication of *Mittheilungen* into a regular *Zeitschrift* developed into the formation of a Zoological and Botanical Society, leaving the geological sciences to the Reichsanstalt. George Frauenfeld, the zoologist, was the founder of the movement, and the first secretary of the Society, which attracted all workers at the study of organisms living and extinct. As in England at that time the biological sciences were largely cultivated by amateurs of the highest birth and rank, so did the young Austrian society gain aristocratic support from the beginning. The first president was Prince Richard zu Khevenhüller Metzch, the second Prince Colloredo Mannsfeld, and we read of the latter that "few were the board meetings from which his Serene Highness was absent." In a country where one-half the population is illiterate, we can understand that education in the highest sense must assume an aristocratic tinge, and the noble particle "von" recurs frequently among the workers whose names are cited. This much we gather from the short history of the Society, related by Dr. Brunner v. Wattenwyl.

In the histories of botany and zoology, those of phytogeography and zoogeography hold the first places. One of the first objects set before the Vienna society at its foundation was the study of the native organisms of the Fatherland, and many of the provincial bodies have devoted their chief energies to this pursuit. When the faunistic and floristic studies of Austrian travellers are added, we can but admire the wonderful and successful work of a country usually held to be rather behind the average advancement of Europe.

But to say this gives no adequate account of the activity of Austrian biologists. In botany, over against such systematists as Endlicher, Fenzl and Engler may be set Unger, the discoverer of cilia in the lower plants; Ingen Housz, one of the fathers of plant physiology; Wiesner and Leitzeb, the histologists and physiologists; Kerner v. Marilaun, whose grasp of plant-bionomics was of the strongest and widest; and Čelakowsky, with his unrivalled knowledge of the morphology of flowering plants and their "monstrosities."

When we turn to the history of zoology we find a similar catholic productivity. Unfortunately, the matter is much more scattered, as we have seen in our survey of the contents of the book. Austrian zoologists, indeed, occupy a commanding position: we need but note C. Claus, systematist and morphologist, whose epoch-making works on the Crustacea and brilliant studies on the Cœlenterates were perhaps second in importance to his stimulating powers as an exponent and teacher; and v. Stein, who practically laid the foundations of our knowledge of the Flagellates. But in every section of zoology Austrians have distinguished themselves, and one of them, F. Eilhard Schulze, is the professor at Berlin.

If we ask ourselves the causes of the extraordinary scientific fertility of a union of countries numbering in all fewer inhabitants than Great Britain, and half of them illiterate for the greater part of the last half-century, the first that presents itself is probably provincial patriotism: each country is anxious that its own possessions shall be duly recognised; and no one can doubt the efficiency of such a stimulus to the capable student of nature. But the desire is useless without the power to accomplish. We can only find this in the encouragement given to children in Central Europe in the study of systematic and descriptive natural history, and especially that of the local flora. This teaches system, careful observation, accurate detailed description and record—a combination of acquirements realised in none of the disciplines in our own school use. Such work may commend itself as essentially "heuristic" to our enthusiastic band of reformers of school programmes. Moreover, it *does not* involve the direct teaching of philosophical ideas, but recently acquired by the pioneers of science and unintelligible to the young mind, which is, on the other hand, trained not to shirk the irksome accumulation of facts: indeed, the results will depend largely on the work of the scholar himself, and not on his passive reception of the teacher's ideas.

Hæckel has, we know, spoken disparagingly enough of mere systematism, and compared it to "postagestampology" (the word "philately" had not then been invented). But we read in the dedication of the "Generelle Morphologie" to Gegenbauer how, as a boy of twelve, he had collected a herbarium of local plants with a set of intermediate forms between the "critical species," and already had been led thereby to doubt the orthodox view of the constancy of species; we know his masterly unravelling and grouping of the appalling wealth of forms in the Radiolaria. De Bary once said to the writer: "Without a good systematic knowledge to begin with, no botanist can tell where he is, nor what he is dealing with." Charles Darwin began as a collector, and monographed the Cirrhipedia, and Alfred Russel Wallace was a collecting naturalist. If we want to place ourselves on a par with Austrian and German biologists we must reform our teaching of botany on the common-sense lines followed so successfully abroad, and once introduced by Henslow into the primary teaching of his village school in East-Anglia. As a preliminary to the morphology and bionomics of our academic programmes, there must be laid a sound foundation in the knowledge of organic external form and variety. And so the scientific training of the individual will be pursued on lines corresponding to the acquirement of scientific knowledge by the race, a course which should, at least in this case, commend itself to all educational reformers. M. H.

GEOGRAPHICAL DISCOVERY.

L'Epoca delle grandi Scoperte geografiche. Di Carlo Errera. Con 21 carte, &c. Pp. xvi + 432 (text, 357). (Milano: Hoepli, 1901.) Price L.6.50.

THIS useful, brightly-written and well-illustrated summary of the geographical progress of Christendom, from the beginning of the Middle Ages, is divided into twelve parts, of which the first eight deal with the pre-Columbian time and the last four with the great age of discovery, from Columbus to Magellan. Among the twenty illustrations are four reproductions of early mediæval maps, from Miller and Beazley, one of Carignano's Portolano of 1300, one of Fra Mauro's map of 1459, one of a section of Juan de la Cosa's chart of 1500, one of the Strassburg Ptolemy of 1513, and one of the 1529 mappe-monde of Diego Ribero. Most of the latter are reproduced from Ruge's "Geschichte des Zeitalters der Entdeckungen." In its text the present work is also mainly based, for its later chapters, upon the same and other works of Ruge's, as well as upon Kretschmer's "Entdeckung Amerikas," Nordenskjöld's "Facsimile Atlas," Harrisse's "Christophe Colomb" and other studies, and Günther's "Zeitalter der Entdeckungen"; for its earlier upon Nordenskjöld's "Periplus," Hughes' "Storia della Geografia," Heyd's "Commerce du Levant," Uzielli and Amat's "Studi biografici . . . sulla Storia della Geografia," K. Miller's "Mappæmundi," Beazley's "Dawn of Modern Geography," Avezac's edition of, and introduction to, Carpini, Yule's Marco Polo, &c.

But although essentially a compilation from more extensive and specialised studies on the history of exploration, Prof. Errera's contribution to the "Collezione Storica Villari" has great merits. It describes with excellent lucidity, compression, and good sense the chief epochs in the great drama of European awakening to a fuller knowledge of the world. No attempt, indeed, is made to treat (except allusively) of Arab or Chinese exploration and geographical study; and it might be said that a somewhat fuller appreciation of the latter is almost indispensable for a complete understanding of the European advance to which Prof. Errera restricts himself. It might also be objected that a chapter on the exploration of the north (No. vii. "La Conoscenza del Settentrione"), including the description of the Scandinavian voyages to Iceland, Greenland and Vinland, should precede, and not follow, chapters (iv.-vi.) on the growing knowledge of Asia among Europeans during the thirteenth, fourteenth, and fifteenth centuries.

Once again, more attention might have been given to the career and first voyage (1497) of Giovanni Caboto; and, to instance a very small point, Konrad Miller's "Ebstorfkarte" is not separate from his "Mappæmundi: Die ältesten Weltkarten," but heft v. of the same. But little fault, as a whole, can be found with the way in which the author brings out, section by section, his epitome of what he defines, in his preface, as the "progressive extension of the knowledge of the superficies of our planet," down to the era of the first voyage round the world.

A special word of thanks is due to the excellent critical judgment with which the difficult voyages of the Zeni are handled—a subject hard enough in itself and doubly hard for a fellow-countryman of Nicolo and Antonio Zeno. Italians, perhaps, did more than any other people—more even than Scandinavians and Portuguese—for the advance of European trade and exploration, as well as for the perfecting of geographical science; from Antoninus of Placentia to Marco Polo and Ludovico Varthema, from Malocello and the Vivaldi to Columbus, Verrazano and the Cabots, from Flavio Gioja to Fra Mauro and Toscanelli, Italian travellers, merchants, and men of science bore a foremost share in the work of opening up the world. Among the early Portolani, the first true maps ever set forth, an overwhelming preponderance (413 out of 498) are Italian; and the whole of modern trade, with all the possibilities of civilising progress which it contains, might almost be called a discovery of Italian genius. Italian scholars of the present day may, therefore, be said to have a special claim upon the subject here discussed, as the subject has a special claim upon them; and although this *breve storia* has not the original value of Marinelli's remarkable study on the geography of the Dark Ages, it deserves a most cordial welcome.

OUR BOOK SHELF.

Die Tierwelt der Schweiz in ihren Beziehungen zur Eiszeit. Von Prof. Dr. F. Zschokke. Pp. 71. (Basel: B. Schwabe, 1901.) Price Mk. 1.20.

HERE in short compass we have set forth the relation of the flora and especially of the fauna of Switzerland to the Glacial period. Geologists have been wont to cite the occurrence of Arctic plants in the Alps and the mountains of middle Europe as strongly confirming their belief in the former prevalence of a glacial climate in what are now temperate latitudes. In his present work the author shows that, however cogent that evidence may be, it is in no degree stronger than that derived from a

study of the animal life, and more particularly of the water-life, of the Alpine lands. After briefly summarising the evidence supplied by the Arctic-Alpine plants, Prof. Zschokke refers to the former distribution of Arctic-Alpine vertebrates in the low grounds at the foot of the mountains, and gives a succinct account of the land-shells, butterflies and beetles met with in the higher Alps—many of which are true Arctic species. The major portion of his treatise, however, is devoted to the origin of the fauna of the Alpine lakes and streams. It would appear that many of the forms now flourishing in the ice-cold waters of the higher Alps hail from Arctic regions. Even in the large lakes at the foot of the mountains a glacial relict-fauna is encountered. Special reference is made to the Salmonidæ of these lakes, which are now cut off from the headquarters of their kind in the far north. They doubtless immigrated from the north during Glacial or early post-Glacial times, when such vast tracts of middle Europe were under water, or traversed by swollen rivers and great "canals," and when many of the Alpine lakes were in free communication. It is noteworthy that the Alps stopped migration further south, and that the fish in question do not occur in the Italian lakes. Eventually the limitation and interruption of water-communication with the north led to the trapping of the Salmonidæ in the great lakes. And now so long a time has elapsed since then that varieties and even new species have been developed. The fish can no longer migrate from lake to sea as their northern cousins do; but it is interesting to learn that at spawning time they still gather in shoals, as if they were about to set out on a journey. Perhaps this may be a remembrance of former conditions. Prof. Zschokke traces very graphically the changes in the life of the Alpine lands which ensued on the gradual disappearance of the extreme glacial climate. In the ice-cold waters of the higher Alps the Arctic types of life flourish at the surface, just as they do in the lakes and streams of Greenland. At the foot of the mountains, however, they are no longer met with at the surface, but have descended to the cold dark depths of the great lakes. As the mountains of middle Europe became at the close of the Glacial period "cities of refuge" to which the Arctic-Alpine flora retreated, so in like manner they have afforded shelter here and there to colonies of those Arctic forms of animal life which are still so abundant in the tarns and streams of the higher Alps, but have their headquarters in the ice-cold waters of the Arctic regions.

A Treatise on Elementary Statics for the Use of Schools and Colleges. By W. J. Dobbs, M.A. Pp. xi + 311. (London: A. and C. Black, 1901.) Price 7*s.* 6*d.*

THE author has already written an excellent book on geometrical statics, and it has been his present object to produce an elementary treatise which shall cover the well-trodden ground of the parallelogram of forces, moments and couples, centres of gravity, work, machines and friction, and at the same time shall develop the subject simultaneously from its geometrical and analytical aspect. It is sufficient to open the book almost anywhere to find evidence of originality in the treatment. Thus in the introduction the author does not leave his readers ignorant of the existence of non-rigid bodies (p. 7). Again, in dealing with the parallelogram of forces, he wisely eschews the fallacious so-called dynamical proof and gives an ingenious modification of Duchayla's proof, together with an experimental verification in which three strings stretched by spring balances, instead of being knotted together, are attached to a triangular string which forms a funicular triangle of the forces. This plan has the advantage of also showing that three forces in equilibrium meet at a point when produced. The proof of the formula for the resultant of two parallel forces is based on the "funicular" method—a change that will be most refreshing to examiners. Whenever a question is set in any examination, in which candidates are asked to find the resultant or centre of a number of parallel forces in such cases as that of a rod loaded at different points, where the answer comes out in a line by taking moments, pages and pages of work are usually sent up with the old familiar figure and proof for the resultant of *two* parallel forces: "(1) when the forces are like; (2) when the forces are unlike," and so on, finishing up with the lame conclusion that the resultant "may be found." The author's treatment of friction strikes us as a very sensible innovation, the laws of friction being based on a consideration of the angle of friction, and the coefficient of friction being defined as the tangent of this angle. There are a few points we do not altogether care about; for example, a crowbar problem on p. 119, where "perfect roughness" exists between the stone and the ground and between the crowbar and ground, and "perfect smoothness" between the sharp edge of the stone and the crowbar. In connection with such a problem, too, the author might do well in Chapter v. to say something about the direction of the reaction when an *edge* of one body rests against, but does not dig into, the surface of another. The book is copiously supplied with examples.

The Country Month by Month. By J. A. Owen and G. S. Boulger. New edition. Pp. viii + 492. (London: Duckworth and Co., 1902.) Price 6*s.* net.

THE best testimony to the appreciation of this work by the reading public is that it has reached a second edition —this being enlarged by the addition of notes written by the late Lord Lilford. Mrs. Owen, who, as editor of the delightful series of books bearing the signature "A Son of the Marshes," has had a large experience of works dealing with English country life, is responsible for the portion of the present volume treating of the habits of animals, while Prof. Boulger has written the botanical portion. The partnership may be said to have turned out in every way a success.

As the authors say in their preface, popular works on natural history absolutely swarm at the present day, but there is no other which gives in such detail the changing phases of animal and vegetable life throughout the twelve months of the calendar. It is, in fact, an expansion of Gilbert White's "Naturalists' Calendar," written in an interesting and attractive style and containing much information which should be of use to the working naturalist. In addition to the accounts of the habits of animals, there are many observations scattered through the book which, if not new, are at all events out of the common.

For instance, on p. 111 we find the remark that while the French commonly name birds from their notes, the English more generally call them after their appearance or habits. The observation (p. 418) that night-herons are increasing in number in Britain may perhaps be connected with the depopulation of country districts of which we hear so much nowadays. And Lord Lilford's note (p. 188) that frogs, small eels and young birds form the favourite food of the otter strikes us as entirely novel, since in Bell's "British Quadrupeds" we are told that "the otter lives exclusively on fish, when it can procure them." Nor do the authors confine their observations to wild animals, an interesting statement being made on p. 468 that the Angora rabbit (or at all events one individual thereof) sheds its coat entire. Misprints and other errors appear few and far between, although on p. 419 we notice "nob" standing in place of "knob." We may add that we fail to see the advantage of putting the date 1902 on a book which was in the reviewer's hands by the middle of November 1901.

To all lovers of the wild nature of our country this work should prove, not only acceptable, but invaluable.

R. L.

Strange Adventures in Dicky-Bird Land. By R. Kearton, F.Z.S. Pp. xiii + 195. Illustrated with photographs direct from Nature by Cherry Kearton. (London: Cassell and Co., Ltd.) Price 3*s.* 6*d.*

"Ugly," a Hospital Dog. With Recitations and Readings. By G. H. R. Dabbs, M.D. Pp. viii + 200. (London: C. W. Deacon and Co., 1901.) 1*s.*

Wonders in Monsterland. By E. D. Cuming. With illustrations by J. A. Shepherd. Pp. xii + 258. (London: George Allen, 1901.)

The Child's Pictorial Natural History. Part I. Pictured by C. M. Park. Pp. 24. (London: Society for Promoting Christian Knowledge, 1901.) 1*s.*

THE four books of which the titles are given above have been published at a time when people are finding suitable gift-books for Christmas presents to children who have an interest in natural history.

Mr. Kearton's volume is an attempt to express incidents in the lives of birds in an autobiographical form. The style of composition is inelegant in places, and it requires a good imagination to think of birds using such colloquialisms as: "It strikes me very forcibly we are in for more hard times," "Good old Bunny," "Guess what got her, and beware my up-to-date young friend," "Go for him, Mr. Missel Thrush." But perhaps this free and familiar form of expression will be appreciated by juvenile readers, who will certainly admire the excellent illustrations.

The first part of Dr. Dabbs's book is also in the autobiographical form, the narrator being a bull-dog who attaches himself to a hospital, and renders assistance to various members of the staff at different times. The second part of the book contains recitations and readings for odd hours.

"Wonders in Monsterland" is a nonsense-book in which the subjects are some extinct animals, disguised under such names as the Master Don, Dino Therium, Phee and Oh-don't-'op Teryx, Icky Ornis, Mackie Rodus and Ann Thropithecus. The narrative is very funny in places, and young people cannot fail to find enjoyment in reading it. The book could appropriately be described as a comic history of extinct monsters.

Popular characteristics of twelve wild animals of other countries, such as the tiger, elephant, wolf and giraffe, are described and illustrated in Mr. Park's book, with occasional Biblical references. A child might profitably read the book in connection with a visit to the Zoological Gardens.

What's What. A Guide for to-day to Life as it is and Things as they are. By Harry Quilter, M.A. Pp. xii + 1182. (London: Sonnenschein and Co., Ltd., 1902.) Price 6*s.* net.

THERE is an astonishing amount of information upon a variety of subjects in this book. The volume is, in fact, a kind of "Enquire Within for Everything," but with this difference—matters of fact are, perhaps, less frequent than matters of opinion. The introduction of this personal element imparts a lightness to the contents not usually possessed by books of reference, but after a while the reader comes to the conclusion that the editor might usefully have abridged his views and those of his contributors in order to increase the number of subjects described.

At present the book cannot be depended upon as a volume of reference; that is to say, words or terms which we expect to find in it are absent as often as not. Something is said about chemistry—not very instructive, it must be confessed—but nothing about physics; light occurs, but not the spectroscope; conservation of energy, but not conservation of matter; the moon, but not the sun; botany, but not zoology; the Hessian fly, but not the gipsy moth or Colorado beetle; hypnotism, but not hygiene; hydraulics, but not pneumatics; pathology, but not histology; geography, but not geology; equator, but not ecliptic; epilepsy, but not paralysis; and these are but a few examples of the inconsistencies of the book. In general, the information given is correct, but the following remarks upon the celestial equator form one of the exceptions to this statement:—"This does not always remain fixed, never passing exactly the same stars, but turning in 26,000 years a little nearer to the axis of the ecliptic. This causes the precession of the equinoxes, each of which occurs 20 minutes earlier in point of time than the last." A reader would be justified in speaking disrespectfully of the equator after trying to understand an explanation of this kind.

The Self-Educator in Botany. By R. S. Wishart, M.A. Pp. xiv + 226. (London: Hodder and Stoughton, 1900.) Price 2*s.* 6*d.*

THIS book is ostensibly written to enable students to obtain a knowledge of botany without receiving personal supervision and instruction. Thus the author sets before himself an onerous task the difficulties of which he has quite failed to realise. Indeed, the book displays throughout the crudest knowledge of the subject, and this is set forth in a loose and disjointed fashion without any particular arrangement or continuity of argument. Even where a good exercise is given, or an instructive experiment described, as at p. 92, the full value is lost through inadequate explanation or incomplete description. The aim of the writer to provide practical scientific knowledge in a logical manner has certainly not been attained; rather it is to be feared that the student who should work through the book will even then find that he does not know much, and most assuredly he will not know accurately.

Bastarde zwischen Maisrassen mit besondere Berücksichtigung der Xenien. By Prof. C. Correns. Bibliotheca Botanica. Pp. 53. (Stuttgart: E. Nägele, 1901.)

XENIA is the name given to the results of the crossing of the plant by a foreign pollen, exhibited in some peculiarity which appears in the seed itself, and does not—as would be the case in a hybrid—remain in abeyance until the plant which the seed produces has grown up.

Thus if a certain race of maize which produces yellow-skinned grains is crossed with pollen from a race which has violet-skinned grains, it is found that the resulting seed in many cases will be violet. It has also been discovered that this is because the potency of the pollen of the violet-skinned race makes itself effective, by means of one of the pollen nuclei, on the endosperm, and the latter acquires a violet outer layer in place of its accustomed yellowish one. In other cases of xenia other characters of the pollen-yielding parent make themselves effective on the embryo-sac—*e.g.* sugary in place of starchy cell-contents.

In the paper under review Prof. Correns has undertaken—and, be it remarked, has very successfully carried out—a large number of experiments on hybrids and xenia of maize, the results of which are set forth in great detail and illustrated by two plates of brilliantly coloured figures.

A Country Reader for Use in Village Schools. By H. B. M. Buchanan, B.A. Pp. vii + 248. (London: Macmillan and Co., Ltd., 1901.) Price 1*s.* 6*d.*

COMMON domestic and wild animals are described in this book in a simple and instructive style, capable of being understood by the elder children in village schools, and by adults who are only familiar with words of every-day life in the country. The book will impart to those who read it an intelligent knowledge of animal life in and around a farm. The illustrations, mostly reproduced from photographs, are very fine.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

Histrionic Capacity of Grey Parrots.

THE capacity of the grey parrot for repeating words and sentences of human language and for imitating the cries and sounds made by other animals, both beasts and birds, is well known. The remarkable aptitude which this parrot shows for "saying the right thing at the right time" is also, I believe, well known to those who have been familiar with intelligent specimens of the bird. But I was not, until recently, aware that the bird can be not only an excellent mimic but also a good actor; and it is possible that some of your readers may be able to give other instances of what I now propose, with your permission, to relate.

My daughter had a very clever young grey parrot, which, unfortunately, died on the first of this month, after a severe illness of three weeks' duration. He was brought to my daughter straight from the nest in Africa, and had he lived another month would have been about two years old. He was a singularly clever bird, and of a charming disposition to his friends, though very shy and inclined to be hostile to strangers. He was an exceptionally good talker for his age, and showed remarkable intelligence in fitting his sayings to the occasion. He was very fond both of fruit and sugar, but I never knew him ask for sugar at dinner or for apple at breakfast. For nuts, which were kept in a cupboard in the room, he would ask at any time; and in many similar ways he showed a vivid association between the words and the things represented by them.

But the remarkable, and to me novel, power which he displayed at so young an age was that of acting. He played with a bit of wood exactly as a clever little girl plays with her doll. For example, he would take the wood in his claw and would say to it, imitating the voice and gestures of my daughter or of one of the servants, "What! are you going to bite me? How dare you? I will take the stick to you!" Then he would shake his head at the wood and say, "I am ashamed of you! Whom did you bite? Go on your perch!" Then he would take the wood to the bottom of his cage, and putting it down on the floor would hit it with his claw several times, saying, "Naughty! I'll cover you up, I will!" Then he would step back from it one or two paces, put his head on one side and say, as he looked at it, "Are you good now?"

No attempt was ever made, deliberately, to teach him this or any other of his histrionic performances. He picked them up spontaneously from his own observation and memory.

It would interest me much to know whether this capacity for acting is often found in grey parrots. D. R. FEARON.

The Athenæum, Pall Mall, S.W.

Use of the Arms in Locomotion.

I CANNOT help feeling a special interest in the two letters appearing at pages 80 and 102 of NATURE. Let anyone stand on a table and jump down, he will find that he throws up the arms to lighten the fall. Let him go quickly up or down stairs and see what use he will then make of his arms.

When I was a small boy, brought up in the country, the motions of the body indicated in these letters were natural ones to me and my brothers and sister. But as I got older I went to school, and at twelve years of age had to join a cadet corps.

Then were the natural movements drilled out of me; the body had always to be square to the front, the arms motionless by the sides. We were exercised on the flat, and one regulation quick step was practised, having one length of pace, one of time and one in stiffness.

At seventeen I went to the Royal Military College at Sandhurst, where the same system was continued, but varied, I was thankful to find, by an excellent gymnastic training.

At eighteen I became an officer and remained as such for ten years, when I retired. During the last four or five years of my service I was adjutant of my regiment and *taught* the system I have described. The British Army was indeed *smart*, it was beautiful to look at, we rejoiced in it, we were proud of ourselves.

Since my retirement in 1878 soldiers are allowed to swing the arms when marching and it is said that since the war in South Africa there are to be many *real* reforms. I shall believe in them when I see them.

At fifty-two years of age I find that in my daily walks or mountain excursions, when I am walking (1) on the flat, (2) uphill, or (3) downhill, then (1) the length of pace, (2) the time of each pace and (3) the attitude and movements of the whole body must differ in each case, so as to ensure the best work with the least possible fatigue, the least risk of falling, overstrain or other mishap. There is an art in the performance of what may seem to some the simplest actions of our lives, and it is surprising what a man can do in climbing the hillside if he knows the right way to set about it.

The British soldier is not properly taught how to march, and the war has abundantly shown that most of his drill is worse than useless.

In building a house it is usual to commence with a good foundation and finish with the roof. But what I read in the newspapers on *officially proposed* Army reform is indeed painful to me. I am a practical man and can assure you that if the British taxpayer is going to be satisfied with the creation of Army boards and Army corps, and a far too large and costly staff—the roof of the Army—and does not see to a solid foundation in a greatly improved training of the individual soldier by the *officers immediately over him—i.e.* company officers, who should be properly paid for their work—and not adjutants and sergeant-majors, he might just as well throw the millions he will be asked to expend into the Atlantic Ocean.

This is not usually the place for the discussion of Army matters, and I must stop here, hoping you will consider that what I have said fairly arises from the lead that has been given me.

But I hope I may urge in conclusion that the arms should be worked habitually by all people, solders and civilians, men and women. Medical men now recognise that in these days of civilisation the leisured classes use the lower limbs far more than the upper ones and that the true way to cure many cases of weak heart, lungs or digestion is to daily exercise the muscles of the arms, shoulders and chest, the healthy action thus set up strengthening the internal organs of the body. Serious cases of nervous disorder and brain trouble can often be successfully combated with a judicious exercise of the arms under skilled advice.

The gist of the whole matter is this. Our lives have become too fictitious; we should go to the teachings of *Nature* and endeavour to be *natural*. GILES A. DAUBENY.

Las Colondalles, Montreux, Switzerland, December 8.

The Value of the Horns in Bighorn Wild Sheep as Ear-trumpets.

IN the case of spiral-horned *domestic* sheep, as observed chiefly in the Alps, the ear is as large as is usual in sheep, and the horn (which grows homonymously, *i.e.* the right horn has a right spiral direction and the left a left) curls round the ear in such a fashion that the ear caged in the open spiral is confined to certain limits by the curves of the horn and lies in the long axis of the open spiral of the horn, from which it only now and then escapes by accident.

An extraordinary difference is seen in the wild sheep, especially to be noted in *Ovis nivicola* (for a figure and description *vide* p. 214, vol. i., Guillemard's "Voyage of the *Marchesa*"). The horns in this creature are enormous, but the ear is remarkably short, though still situated exactly in the axis of the spiral and in such a fashion that the ear appears to be at the apex of a hollow cone formed by the great spiral horn. A similar condition and relation of ear to horn is found in *Ovis montana*, the Siberian argali, and others. The form of the horn and the position of the ear enables the wild sheep to determine the direction of sounds when there is a mist or fog, the horn acting like an Admiralty megaphone when used as an ear-trumpet, or like the topophone (a double ear-trumpet, the bells of which open opposite ways) used for a fog-bound ship on British-American vessels to determine the direction of sound signals.

By taking a horn off the skull the listening ear, if properly placed, can distinguish the tick of a watch in one position best in the axis of the coil, and thus test the value of the horn for determining the direction of sounds—though no evidence of improved hearing for distance could be discovered by any such simple experiment. The functions suggested would be especially of advantage to wild sheep when feeding on mountains in mist and fog in making them more wary and difficult of approach.

Cambridge, December 7. GEORGE WHERRY.

The Influence of Temperature on the Action of Nitric Acid on Metals.

THE following simple but striking experiments illustrating the influence of temperature upon the action of nitric acid on metals may possibly be of interest to those who are engaged in the teaching of chemistry.

If three tubes containing strong nitric acid are cooled below $-10°$ C. by means of a freezing mixture of snow or pounded ice with salt, and then copper turnings added to one, granulated zinc to another and magnesium ribbon to the third, it will be found that no action takes place, the nitric acid being practically inert at this temperature. If the tubes are then exposed to air at about 22° C. so that the temperature rises slowly, it will be found that little or no action occurs until a certain temperature is reached, when a sudden and violent ebullition of brown fumes occurs, the metal rapidly dissolving and the temperature abruptly rising from 80° C. to as much as 104° C.

The critical point for this violent action lies in the case of zinc between 0° C. and 2° C., in that of magnesium between 17° C. and 19° C., and in that of copper between 19° and 21° C. Before these temperatures are reached very feeble action may occur and a few bubbles of gas be disengaged, especially in the case of the zinc. These bubbles consist partly of hydrogen gas, and if magnesium is added to cold dilute ($\frac{1}{6}$–$\frac{1}{8}$) nitric acid an active evolution of nearly pure hydrogen takes place at first, although as the solution becomes warm and the percentage of magnesium nitrate increases, the production of hydrogen rapidly diminishes. This is in somewhat striking contrast to the common statement in chemical text-books to the effect that in no circumstances can hydrogen be obtained by the action of nitric acid on metals. ALFRED J. EWART.

Meteorological Work for Science Schools.

IT has often occurred to me that the collection of data, such as those necessary for the investigation of fog distribution, might well be entrusted to the science schools over which the Technical Education Board of the London County Council exercise control.

There is, in such a research, that element of originality which is needed in the work of our school laboratories.

For interpretation the collected data may afterwards be distributed to the schools engaged in the work.

I foresee only the difficulty due to the intervention of vacations. J. V. H. COATES.

41, East Dulwich Grove, S.E., November 25.

[We have referred the foregoing letter to the Secretary to the Meteorological Council, who has been good enough to send the following remarks upon it.—Editor, NATURE.]

THE primary difficulty in the way of using science schools, as suggested by Mr. J. V. H. Coates, for the immediate purposes of such an inquiry as that of the distribution of fogs is that the schools have fixed hours of attendance to which the fogs pay no heed. To carry out such an investigation effectively the twenty-four hours must be taken into account. Of course the inquiry might be restricted to those fogs which begin or end within the hours of attendance, but that would be a very serious limitation. As confirmatory evidence, careful observations within school hours might be very useful. The necessity for securing a suitable uniformity among observers as regards the terms employed in the estimation of fogs makes it necessary, however, to proceed with caution in extending the number of separate observers.

The kind of cooperative investigation which is appropriate for organised science schools is one which can be dealt with primarily by observations at fixed hours. On special occasions it might doubtless be pursued beyond those hours in following up some definite point. Several inquiries of this nature may be suggested. For example, in relation to the fog inquiry, it is desirable to know something of the effect of wet ground during rapid falls of temperature. For this purpose an investigation of the temperature of wet soil or sand suitably exposed and its relation to the temperature of the air would be a very useful adjunct to the ordinary meteorological data. It is a part of the inquiry more suitable for science schools than for routine observation, because the conditions of exposure require examination and consideration as well as the readings of the thermometers. The hours of non-attendance could be bridged by registering minimum instruments or, in some enterprising schools, by self-recording instruments, the development and investigation of which would be in themselves a useful study.

Another line of cooperative inquiry, of much greater difficulty, suggested to me in various forms by several scientific friends, has reference to the large amount of fuel consumed daily within the London area. The combustion must of necessity raise the temperature of the air in or over London above that of its surroundings. The raised temperature should give rise on calm days to a diminished pressure and an inflowing air current. Ordinary meteorological observations are not of a sufficiently high order of accuracy to exhibit these effects, but by cooperative, and in the best sense competitive, effort between science schools in different parts of the metropolis progressive steps could be reached which might ultimately have the very satisfactory result of exhibiting quantitatively the effects of the local heating. If this ultimate purpose should not be achieved, the light thrown upon the practicable limits of observation would not be without interest.

Then, again, the chemical composition of air at different points during foggy days would be a useful inquiry. Probably the results obtained at the first attempt would not be accepted as final, but the discussion of the results from different centres would lead to more accurate determinations and ultimately to definite information of substantial value. Incidentally, such co-operative inquiries would be of very great educational influence and advantage. Supposing, for example, that it were decided to make observations of any rapidly varying element at a definite point of time, the mere carrying out of the comparison of the time-keepers at the different schools would be most instructive. The comparison of their length-standards with a view to accurate barometric measurement might be beyond the reach of available apparatus, but even the demonstration by appeal to experience that the best comparisons that could be effected with the apparatus at command, left a margin of inaccuracy of a certain defined magnitude would be sufficiently instructive to make the experiment worth trying. W. N. SHAW.

November 30.

The Date of Stonehenge.

THE remarkable paper on Stonehenge, by Sir N. Lockyer and Mr. Penrose, in NATURE of November 21 has greatly interested me. Just two years ago I was working at the subject, and wrote to Prof. Petrie to inquire what azimuth he had used for the axis of the temple in his estimate of the date, which he gives as 730 A.D. ± 200 years, with a possible date of 400 A.D. As I received no reply I employed the angle 50° 12′ E. of N., given in Mr. Edgar Barclay's "Stonehenge," 1895. With this azimuth I obtained by means of a formula, kindly supplied by Dr. Downing, F.R.S., a date of 425 A.D. I find that, for the given azimuth, even this date is too early, as I did not allow enough for refraction, &c. Applying the same formula to the figures given in Sir N. Lockyer's paper, the date comes out about 1700 B.C., as stated, so that the formula was correct, and the chief error was in the erroneous azimuth of the axis, which differs by about 38′ from the 49° 34′ 18″ so carefully determined in the published paper. Now as an increase of some 90″ in sunrise azimuth at the solstice means a decrease of some 46″ in declination and represents the lapse of about a century, the discrepancy is clearly explained. Allowing for refraction, &c., I make the present azimuth of the sun at sunrise at the solstice about 50° 26′ 21″ E. of N., the sun's declination being 23° 27′ 8″ N. Consequently since the date, 1700 B.C., the solstitial sunrise azimuth has shifted 52′ 3″ further E. and the declination has decreased 27′ 22″, representing a lapse of about 3600 years, when the appropriate formula is applied.

At the distance (250 feet) of the Friar's Heel, or Sun-stone, from the centre of the ruin, a change in azimuth of 52′ would shift a point on the axis only 3 feet 9 inches, and, as the avenue is 50 feet wide, some idea may be formed of the necessary delicacy of the measurements. The azimuthal shift of the sun himself is less than two diameters. It seems to me very improbable that any estimate of the date closer than that arrived at by Sir N. Lockyer and Mr. Penrose can be made on astronomical grounds. Recent excavations have given valuable information, but much more yet remains to be done in this direction. I may add that an exhaustive study of the "Blue-stones" (igneous rocks foreign to the locality) by the methods of modern petrology may lead to

some definite knowledge of their origin and so throw fresh light on the whole problem. C. T. WHITMELL.

Leeds, November 23.

P.S.—For sunrise (in accordance with p. 57) I take the tip of the visible sun to be 2′ above the local horizon.

Change of Pitch in certain Sounds with Distance.

SEVERAL years ago the late Prebendary Simpson, of Fittleworth, Sussex, told me of an interesting observation he had made, which some of your readers may be able to explain. While walking up and down the platform of a railway station, he noticed a peculiarity in the sound of a steam jet from an engine standing on the lines. The pitch of the sound appeared to rise as he retreated from the engine and to fall as he drew near to it. Some time after, Mr. Simpson observed the same thing again, but in this instance the noise was made by a gas flare in the open air, about which some men were at work. Since then I have found that this alteration of pitch with distance occurs with any fizzing noise of the kind, such as that of air jets, burning logs, frying fat, pouring rice or coffee beans, waterfalls, or even the rustling leaves of a single tree; with all those noises, in fact, whose sources are sufficiently localised to admit of observations of the kind being made. I found, also, on withdrawing from such a source that a point is reached after which the pitch ceases to rise, and remains practically stationary as far onward as the sound continues audible. This point is sometimes pretty definitely marked, and varies in distance from the source with different sounds, and the pitch of the stationary portion also varies in the same way. I do not think, however, that the pitch of the whole volume of sound changes, though it often appears to do so, for a similar impression is created by moving a fizzing air jet to and fro close to a wall. As it nears the wall, the whole sound seems gradually to rise in pitch and to sink again as the jet is withdrawn. But here the effect is clearly due to successive reinforcement of one part of the noise after another in the order of their wave-lengths. It is only a shifting of the point of greatest intensity, and not an actual change of pitch at all. Assuming, then, that the effect noticed by Mr. Simpson is of the same nature, that is to say, caused by a readjustment of the relative intensity of the parts, how is it to be accounted for? Is it simply a process of *sifting* by distance, the weaker groups of small noises, of which the fizzing sound is composed, dropping out of earshot in succession, as the observer retires from the source, till only the largest and loudest group is left, which last continues to be heard for the remainder of the distance without sensible change of pitch? If that is so, then the deeper tones of such noises would seem to have a proportionally shorter range of audibility than the higher ones; for, so far as I have observed, the pitch always sinks on approach to the source and rises on withdrawal from it, never the reverse way, as might be expected in the case of very bass roaring sounds. Perhaps, however, others may have noticed instances of the latter sort. The behaviour of the air-jet fizz at the wall illustrates a kind of reciprocal action, which no doubt plays an important part in the adjustment of the pitch. The tone which is loudest for the moment appears to dominate and obscure the rest, so that, near the source, where the deeper tones are most powerful, these latter, to some extent, subdue and lower the principal one, while further off, where they become enfeebled by distance, they are in their turn still more diminished by the presence of the principal far-reaching tone.

Downshire Square, Reading. FREDERICK M. WEST.

Pine Grosbeak in Berkshire.

Is it not of rare occurrence that a pine grosbeak (*Pyrrhula enucleator*) has been seen here, not on one day, but on two? I was informed this morning that Mr. O. T. Perkins had seen this handsome bird out of his window, apparently either eating beech buds or else hunting for insects on them. During this the bird was attacked by three sparrows, who began making a great noise and eventually drove him off. This morning I saw the same grosbeak, or another one, in a like manner feeding on beech. And what is more strange he was again attacked by sparrows and had to beat a hasty retreat. I may add that the bird, to all appearances, was in excellent condition, its plumage being brilliant. I wonder if any other of your readers have noticed any of these handsome but rare birds? C. M. ROGERS.

Blucher, Wellington College, Berks.

THE "ARMORL" ELECTRO-CAPILLARY RELAY.

WE commented in our notes columns a short time ago upon the announcement that a new system of wireless telegraphy had been worked out by Messrs. Orling and Armstrong. From what could be gathered from the information at that time available we judged that the method made use of earth conduction; we have since learned that this is the case and that the inventors rely upon the novel design of their transmitting and receiving apparatus for the efficiency of their results. We have had an opportunity of inspecting drawings of the receiving apparatus, and are enabled to give a description of it, though we have not seen the actual apparatus itself, but only a working model. We understand that it is proposed to read a paper shortly on the transmitter before one of the scientific societies and that in consequence it is not desired to publish the details of its construction as yet. It is to be hoped that

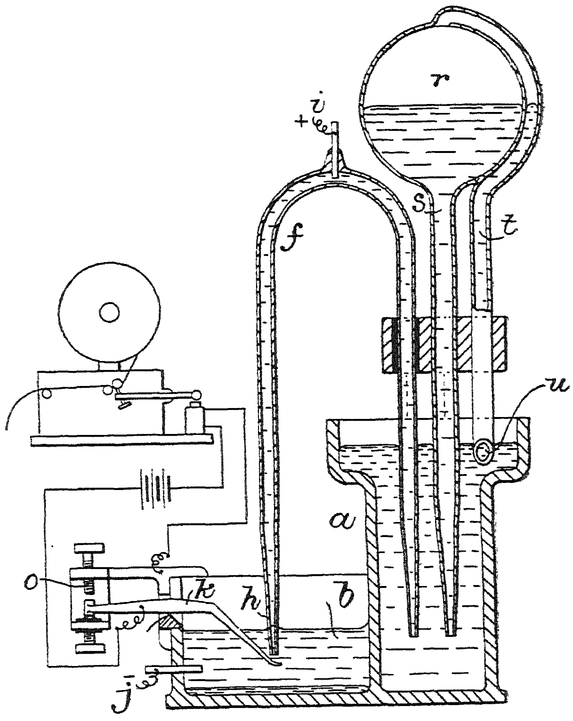

FIG. 1.—"Armorl" Electro-capillary Relay. Syphon form.

at the same time an account will be given of the experimental results obtained, with trustworthy data from which the probable value of the invention may be gauged, for as yet there is nothing to go upon but the statements of the inventors.

In the meantime we must content ourselves with giving a description of the receiver, which is of interest independently of its use with the Orling-Armstrong or any other wireless telegraph, as it could be used for the detection of any sort of electrical current. The instrument consists essentially of a capillary electrometer which is arranged so that it can actuate a relay. The extreme sensitiveness of the capillary electrometer for very small currents and low electromotive forces is well known, and the instrument is used considerably, especially for physiological work. The arrangement adopted in the present instance is shown in Fig. 1. A syphon, *f*, is

filled with mercury, one limb dipping into a vessel of mercury, *a*, and the other into a bath of dilute acid, *b*, the level of the mercury being considerably higher than that of the acid. The mercury is prevented from syphoning over by drawing out the end, *h*, of the syphon into a capillary tube. A contact is sealed into the top of the syphon at *i* and a second contact is made to the acid at *j*. When a difference of potential is set up between *i* and *j* in such a direction that *i* is positive to *j*, the capillary forces are overcome and the mercury syphons over; in so doing the mercury as it flows out of *h* falls on to a delicately balanced lever, *k*, which is thereby tilted and makes contact with a stop, *o*, thus closing a local relay circuit. The level of the mercury in *a* is maintained constant by means of the arrangement shown to the right of the syphon: a reservoir, *s*, is partly filled with mercury, which is held up by keeping a partial vacuum in *r*; when the level in *a* sinks the end, *u*, of the side tube, *t*, is opened, thus allowing a certain amount of air to enter and causing mercury to flow out until it again closes the aperture.

In a modification which has been devised the lever is arranged outside and beneath the vessel *b*, which is then provided with a capillary hole at the bottom just above the end of the lever. The bottom of the vessel is in this case covered with mercury, over which acid is poured

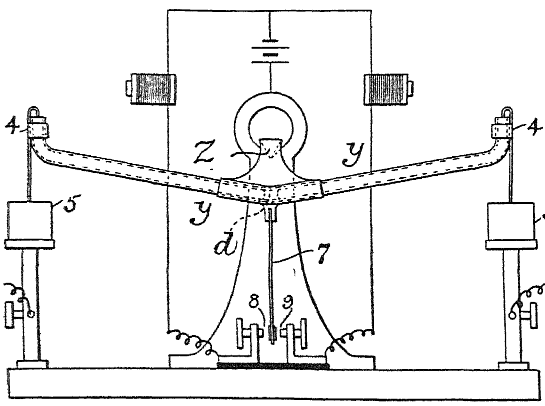

FIG. 2.—"Armorl" Electro-capillary Relay. Balance form.

until the forces of gravity and capillarity are just balanced. When more mercury syphons over a corresponding amount escapes through the hole in the bottom of *b* and actuates the lever. The lever may here be replaced by two platinum points, the falling mercury being then made to bridge the gap between the points and thus complete the relay circuit.

An alternative form of the apparatus is shown in Fig. 2. A glass tube, *y*, is balanced on a knife edge, *z*, and is filled with mercury except for a drop of acid in the centre at *d*. The current is led into this tube through metal rods, 4, 4, dipping into mercury cups, 5, 5. If a current is passed through the tube the meniscus between the mercury and acid is displaced in the direction of the current and the balance is consequently disturbed, as one arm now contains more mercury than the other; the pointer, 7, is deflected and makes contact with either the stop 8 or 9 and thus closes the local circuit. The construction is, however, said not to be so satisfactory as that shown in Fig. 1. It is claimed that the apparatus is extremely sensitive and very trustworthy in its action, and even that it could be used as a substitute for the coherer in ætheric telegraphy or the syphon recorder in cable work; but these claims remain to be established in practice.

THE OASIS OF KHARGA.[1]

DURING the last few years the Survey Department of the Public Works Ministry of Egypt has shown considerable activity in the prosecution of investigations connected with the geological survey of the valley of the Nile, and the publications which it issues from time to time show that the results which it obtains from them are of great interest and importance. Until comparatively recently the conclusions formed about the stratification of Egypt and its past geological history were based upon researches which were undertaken without sufficient preparation, often indeed without sufficient knowledge on the part of those who made them, and the statements made on the subject were often confusing and sometimes contradictory. Under the direction of Sir W. Garstin, however, things have taken a turn for the better, and the geological publications prepared with his sanction and approval really help to put our knowledge of the geology of Egypt upon a sure base.

The publication before us, by Mr. John Ball, is interesting from every point of view and reflects great credit upon the department to which he belongs. There is much in it, of course, which will appeal only to the engineer and geologist who are concerned with the practical administration of the district of the Oasis of which it treats, but there is also much which will claim the careful attention of the archæologist and antiquary. The work is divided into four chapters, which treat of the surveying methods employed and their general results, of the roads between the Nile Valley and the Kharga Oasis, and of the topography and geology of the Oasis; besides these we have an introductory chapter, five appendices, nineteen maps and plates, and sixteen illustrations. The book is satisfactory because it tells us, not only what are the results which have been obtained, but also *how* they have been arrived at, and the plans, maps, and illustrations enable the reader to follow these results with ease.

The Oasis of Kharga has been a source of wonder to untold generations of men, and the curiosity of all cultivated students has been roused more and more as each traveller has returned from it and unfolded in his written descriptions of the place stories of its people and antiquities. Concerning the origin of the Oasis experts are in doubt, but Mr. Ball thinks that its whole area has undergone disturbance which has resulted in folding and faulting; and since the faults affect the highest rocks on the plateaux, it is clear that they took place since the deposition of all the strata which are now found in the Oasis, the calcareous tufa, of course, excepted. The date of the folding and faulting cannot be fixed precisely; all that can be said from the examination of the Oasis itself is that it took place since Lower Eocene times. It is possible that it may be connected with some younger faulting seen in the Nile Valley at the First Cataract, but we have as yet insufficient information for a definite connection of this faulting with the folding of the strata in the Oases. The faulting produced much cleaving and crushing of the rocks, but we have to find out what was the particular agency which excavated and carried away the cracked-up limestones, and to account for disintegration and removal of hundreds of cubic miles of limestone rock, some of it being of considerable hardness. It is probable that the excavation was begun by the action of water, and that after this ceased, owing to a total change in the climatic conditions, *i.e.*, the change from a moist climate to a dry one in Egypt, the work was continued and is still going on by the agency of wind and sand. The superficial erosion both of the Oasis and of the hills within and round about it is due to wind-borne sand, but this has never been realised by travellers, for they have usually visited

1 "Kharga Oasis; its Topography and Geology." By J. Ball. (Cairo, 1900.) Pp. 82.

the Oasis in the calm winter and spring months. Even at the present day the Oasis is enlarging its boundary, and the surface of the plateau is being ground away by sand, and the underlying clays on the faces of the scarps are being steadily excavated. The water in the Oasis is derived from the rainfall of the highlands in the interior of Africa, which, coming by way of the permeable underground strata, appears where these strata rise to the surface or are pierced by wells, though strangely enough the wells are chiefly on the down-throw side of the fault, *i.e.* to the eastward of it.

The history of the Oasis of Kharga in its relation to Egyptian history is full of interest in every way. That it was well known to the Egyptians under the Early Empire is tolerably certain, for from the inscription of the officer Una who made expeditions into the deserts of Libya and the Sûdân we know that the tribes of the districts in the neighbourhood of it were in the habit of waging war against each other. Under the eighteenth dynasty the Oasis of the North and the Oasis of the South were subject to the great kings Thothmes III. and Amenhetep III., and there is no doubt that a considerable trade between them and Egypt was in existence in still earlier times. Every now and then the tribes revolted against the rule of Egypt, but their triumph was short-lived, for Egyptian soldiers appeared and the rebellion was stamped out in a peculiarly firm manner, and the trees were cut down and the gardens destroyed. In the twenty-second dynasty the Oases were still reckoned as a part of Egypt, and under the Persians Kharga was chosen by Darius I. as the site of the fine temple which he built there; this temple was finished by Darius II., and must have been, judging by its present remains, a striking and a remarkable object. It is curious to note that the Egyptians at one time believed that the souls of the dead made their way to the Oases, and it is obvious that the green fields and gardens full of vines and palm trees easily connected themselves in their minds with the Elysian Fields, wherein every Egyptian hoped eventually to live. Before the end of the twenty-sixth dynasty Kharga was used as a place of banishment for criminals and evil doers, and the Romans found it necessary to maintain a garrison at Hibis, the chief city of the Oasis, to keep order. Christianity was introduced into the Oasis by one of the Apostles, who is said to have died and been buried there, and when Nestorius was banished there A.D. 435 he found flourishing Christian communities at several places in the Oasis who would, no doubt, accord him a far from hearty welcome.

Mr. Ball has consulted the works of travellers such as Cailliaud and Hoskins, Rohlfs and Brugsch, and although he has little new to say about the temples and other buildings which they described, his notes on the temples of Hibis, Nadura, Kasr al-Guehda, Kasr Zaiyân, Kasr Dûsh, or Kysis, are most useful, especially as they are accompanied by clear plans. His remarks on the Christian antiquities are somewhat meagre, but then he is an engineer and not an archæologist. In the next edition of his work the paragraph on p. 78 in which he states that the Christian tombs are those of the followers of Nestorius should be modified, for we know on the authority of Christian tradition and writings that there were several congregations of Christians in the Oasis of Kharga one or two centuries before the time of Nestorius, and it is evident that they must have left graves behind them. The tombs may then as well belong to the third and fourth as to the fifth and sixth centuries; and seeing that Nestorius was a violent opponent of the Monophysites in Egypt, it is more than doubtful if he had any followers at all among the Jacobite Christians of Kharga. But these considerations in no way affect the value of Mr. Ball's engineering work, though they do show that an engineer is not also necessarily an archæologist.

SIR WILLIAM MACCORMAC, BART., K.C.B., K.C.V.O.

SIR WILLIAM MACCORMAC, whose death occurred suddenly and unexpectedly on the morning of December 4 at Bath, where he had gone for treatment of an illness which his intimate friends, although feeling considerable anxiety on his behalf, little thought would end so tragically, was one of the most prominent figures in the medical profession in London. He was the son of a well-known Belfast physician, Dr. Henry MacCormac, the author of such philosophical works as "The Philosophy of Human Nature," published in 1837, and "Aspirations from the Inner Life," in 1860, as well as of works on the nature, treatment and prevention of consumption, which attracted much attention at the time and have come again into notice recently as having anticipated the modern doctrine of the open-air treatment of tubercular disease. Sir William MacCormac was born in Belfast on January 17, 1836; he was educated in his native city and graduated as M.A. of the Queen's University of Ireland in 1858. He subsequently studied medicine in Dublin and Paris and became a Fellow of the Royal College of Surgeons, Ireland, in 1864, entering at the same time into the active work of his profession as surgeon to the Royal Belfast Hospital, a post which he held until 1870.

On the outbreak of the Franco-German war he returned to Paris and offered his services to the French Red Cross Society, "*La Société de Secours aux blessés militaires.*" His offer was accepted and he was ordered to Metz, where he was taken prisoner, released and sent back to Paris. It was then that, along with Mr. Furley, now Sir John Furley, and Dr. Philip Frank, he came in contact with Dr. Marion Sims and other Americans (who had come over with a large quantity of material, but with little or no funds), and established the Anglo-American Ambulance with the financial assistance of the National Aid Society, which had been formed in London at the beginning of the war. The Ambulance proceeded at once to Sedan under the charge of Dr. Marion Sims, with MacCormac as second in command, and arrived there in time to take an active and prominent part in the decisive battle of the campaign. At Sedan MacCormac was in his element, and it was there that he laid the foundation of his future greatness. His "Notes and Recollections of an Ambulance Surgeon," published in 1871, vividly described his experiences of the battle and the absorbing, incessant work of a surgeon in the midst of carnage. The book has been translated into German, French, Dutch, Italian, Russian and Japanese, and has made his name a household word amongst the military surgeons of Europe. When the pressure of the work in Sedan was over MacCormac returned to England, and with the assistance of the influential committee of the National Aid Society was appointed to the staff of St. Thomas's Hospital, which had just been opened. He took the Fellowship of the Royal College of Surgeons, England, at the same time, and remained associated with St. Thomas's in the varying capacities of assistant surgeon, surgeon and lecturer on surgery in the medical school, and consulting surgeon and Emeritus lecturer on clinical surgery. He also held many other consulting appointments in London and was examiner in connection with the naval and military medical services.

His reputation as an authority on gunshot wounds was not allowed to lapse for want of opportunity. In 1876 he accompanied the late Lord Wantage, then Colonel Loyd-Lindsay, to Alexinatz during the war between Servia and Turkey. His period of stay at the seat of war was, however, brief, as he and his companion were obliged to take flight with the retreating army. In 1899 he was appointed a consulting surgeon to the field force in South Africa, and saw much of the results of the earlier and fiercer struggles of the war.

The European fame of Sir William MacCormac as a British surgeon almost equals that of Lord Lister. Honours were showered upon him by the Governments and learned societies of foreign States, and his friends included some of the most famous continental surgeons of modern times. Stromeyer, Esmarch, Langenbeck, Coler, Billroth, Mundy, Larrey, Pozzi and many others knew and admired his work and valued his friendship, while his commanding presence was recognised and acclaimed in all assemblies of military surgeons, wherever he went. Indeed it may be said of him that no man in this country kept up his connection with colleagues abroad as he did. His hospitality to them and to all his friends was proverbial.

MacCormac's minor contributions to the literature of his profession are chiefly found in the St. Thomas's Hospital reports and in the medical journals. His larger works, in addition to articles on "Gunshot Wounds" in Heath's "Surgery," "Diseases of the Bones and Joints" in Quain's "Dictionary of Medicine," and "Hernia" in Treves' "System of Surgery," are "Antiseptic Surgery," the development of an address delivered at St. Thomas's Hospital, published in 1880 and translated into French and Russian, and "Surgical Operations," the first part of which, the ligatures of arteries, was published in 1885, and the second, operations on joints and nerves, in 1889. With the exception, however, of his "Notes and Recollections of an Ambulance Surgeon," none of his writings are likely to have the same historical interest as his father's work on consumption, and it can scarcely be claimed that the success of his career was due to any exercise of a power for scientific investigation, although he undoubtedly possessed that power. He was skilful as an operator, lucid and loved as a teacher; but it was his wisdom in counsel, the sanity of his judgment, the common sense of his oratory, rather than any marked advances made by him in the science and art of surgery, that gained him the unique distinction of being elected president of the Royal College of Surgeons four times in succession. He was knighted in 1881 for his services as general secretary of the Seventh International Medical Congress in London, and was created a baronet on the occasion of the Queen's Jubilee in 1897. He was appointed a K.C.V.O. in 1898 and a K.C.B. in February last after his return from South Africa. He was appointed Surgeon-in-Ordinary to H.R.H. the Prince of Wales and Honorary Sergeant-Surgeon to the King on his Majesty's accession to the Throne. The last year of his life was somewhat saddened by the controversies that arose in consequence of his outspoken support of the Army Medical Service during the war. He felt bitterly how much the country had been misled by those who decried the work of the Army medical officers and who knew little of war and still less of the surgical possibilities of war.

Sir William MacCormac married, in 1861, Miss Charteris, of Belfast, but had no family. Lady MacCormac, who was his life-long companion and accompanied him wherever he went, survives him.

The funeral of Sir William MacCormac took place on Monday, the first part of the funeral service being observed at the church of St. Peter, Vere Street. His Majesty the King was represented by General Godfrey Clerk. The French and German Embassies in London were represented, respectively, by M. E. Daeschner and Major Count von Bredow. The French Consul-General in London was also present. The council of the Royal College of Surgeons was represented by Mr. J. Langton, Mr. H. G. Howse, Mr. T. Bryant, Mr. A. Willett, Mr. R. Harrison, Mr. H. T. Butlin and Mr. W. W. Cheyne. Prof. C. Stewart, conservator of the museum, was also present, as well as many others connected with the Royal College of Surgeons and the profession of surgery. The Royal College of Physicians was represented by Sir W. S. Church (president), Sir Dyce Duckworth (treasurer) and Dr. E. Liveing (registrar). Of St. Thomas's Hospital, with which Sir W. MacCormac had been so long connected, there were many representatives. Among other institutions represented were the French Hospital, the Army Medical Department, Medical Department of the Navy, the Italian Hospital, Queen Charlotte's Hospital, the University of London, the British Museum and the British Association. Among many others present were Lord Lister, Sir William Broadbent, Sir Norman Lockyer, Sir Thomas Smith, Sir Lauder Brunton, Dr. T. Seymour Tuke, Dr. P. H. Pye-Smith, Major-General Sir Owen Tudor Burne, Mr. Andrew Clark, Sir J. and Lady Fayrer, Dr. and Mrs. D'Arcy Power, Sir F. and Lady Semon, Lady Dyce Duckworth, Sir A. S. Wells, Sir S. Wilks, Sir J. W. Williams and Sir James Blyth.

THOMAS MEEHAN.

THE eminently successful life of Thomas Meehan, distinguished as a gardener, a botanist and a citizen, closed on November 19. Mr. Meehan was born in London in March 1826, and received what little schooling he had in the Isle of Wight, where his family had settled. Leaving school at an early age, and displaying a marked aptitude for gardening, he was employed under his father in the gardens of Colonel Francis Vernon Harcourt, at St. Clare, near Ryde. When only fourteen he succeeded in raising the first hybrid Fuchsia, St. Clare, and in appreciation of a paper which he published on Rubus was elected, when only nineteen, a member of the Wernerian Society. After holding various gardening appointments he entered the Royal Botanic Gardens, Kew, in 1846, on the recommendations of Dr. Bromfield and Prof. C. C. Babington. At Kew, where he stayed a little more than two years, he made the acquaintance of Berthold Seemann, with whom he was a candidate for the appointment of botanist to the *Herald* expedition. On leaving Kew he became head-gardener to the Earl of Shrewsbury at Alton Towers, a post which, owing to his religious opinions, he was soon obliged to relinquish. Though offered tempting inducements to remain in his native country, Meehan determined to make America his home, and reached Philadelphia in March 1848.

His career there opened in the humble position of a nursery labourer. But advancement quickly followed. He obtained employment in the famous Bartram Gardens of Philadelphia, and in 1853, with remarkably little capital, established a nursery business of his own, which, in conjunction with his sons, he continued to the end of his life. He was a voluminous writer on horticultural and botanical subjects. He founded the well-known *Meehan's Monthly*, and half a century ago published his "Handbook of Ornamental Trees." In 1878-79 appeared "The Native Flowers and Ferns of the United States," a handsome illustrated work in two large octavo volumes. His botanical papers contributed to various scientific journals, and chiefly to the *Proceedings* of the Academy of Natural Sciences of Philadelphia, number considerably more than a hundred. Enthusiastic in all his undertakings, Meehan became a leading member of the Philadelphia Academy, of which he was vice-president for more than twenty years; a representative of his ward in the Common Council, and a member of the local school board; while his botanical attainments secured for him the proud position of Botanist to the Pennsylvania State Board of Agriculture.

Reviewing his life's story, the heroic toil, the splendid energy, the brilliant success achieved in spite of all obstacles, a tribute of praise such as this, and from a far wider world, is due to the memory of Thomas Meehan.

S. A. SKAN.

THE PHOTOGRAPHS OF NOVA PERSEI.

REFERENCE has already been made in NATURE to the important photographs of the nebula associated with Nova Persei obtained by Mr. Ritchey at the Yerkes Observatory with the 2-foot reflecting telescope, the exposure being four hours. The *Astrophysical Journal*

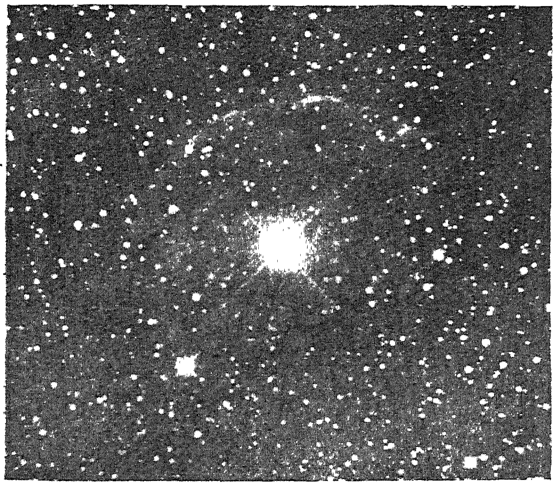

FIG. 1.—The Yerkes Photograph, September 20.

for October contains an enlarged (five diameters) copy of the photograph and a diagram made from the original negative, which are now reproduced.

Still more recently the results secured at the Lick Observatory by Mr. Perrine with the Crossley 3-foot reflector with an exposure of more than seven hours, which were telegraphed over in the first instance, have now reached us in some detail. The communication (*Bulletin* No. 10) is accompanied by a diagram which shows remarkable changes of position in the more pronounced condensations. This diagram is referred to as follows:—

"The four masses of nebulosity are designated by the letters A, B, C, D; the positions which the centres of figure occupied on September 20, as shown in the reproduction from Mr. Ritchey's photograph, are occupied by the left-hand or north-west end of each of the short lines; the positions on November 7-8 are occupied by the right-hand or south-east ends of the lines.

"The line drawn between these positions for each condensation indicates the direction and amount of motion in the interval of forty-eight days. Condensation A is much the best adapted for accurate measurement, from its greater strength and from its forked appearance; condensations B and C are not quite so good for measurement as A, but still are very determinate; but while condensation D is the brightest of all, it is large, and so near the image of the Nova as to make its amount and direction of motion somewhat uncertain.

"It will be seen that the displacements agree well and amount to about $1\frac{1}{3}'$. The directions are not so consistent and could perhaps be explained by irregular motions in the nebulous mass, by a general translation of the nebula in one direction or by a spiral motion. It is certain, however, that the motion is not radial.

"The amount of motion is almost incredible, being no less than at the rate of 11′ per year. The greatest displacement (proper motion) in the stellar universe, so far observed, is less than 9″ per annum."

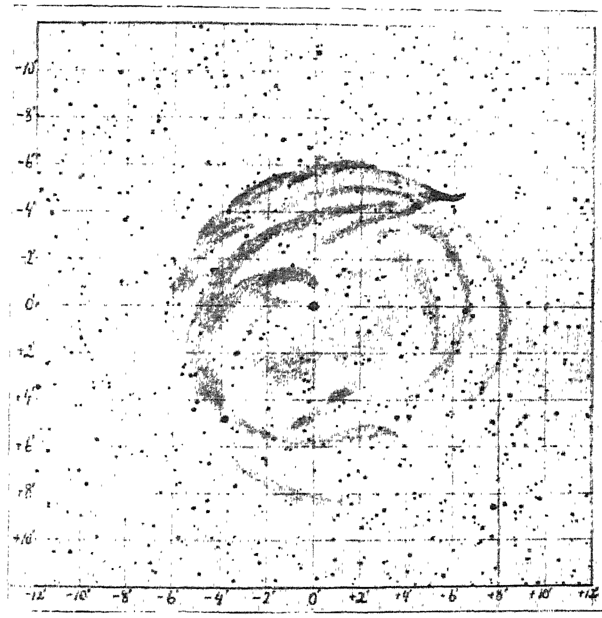

FIG. 2.—Drawing showing details and condensations.

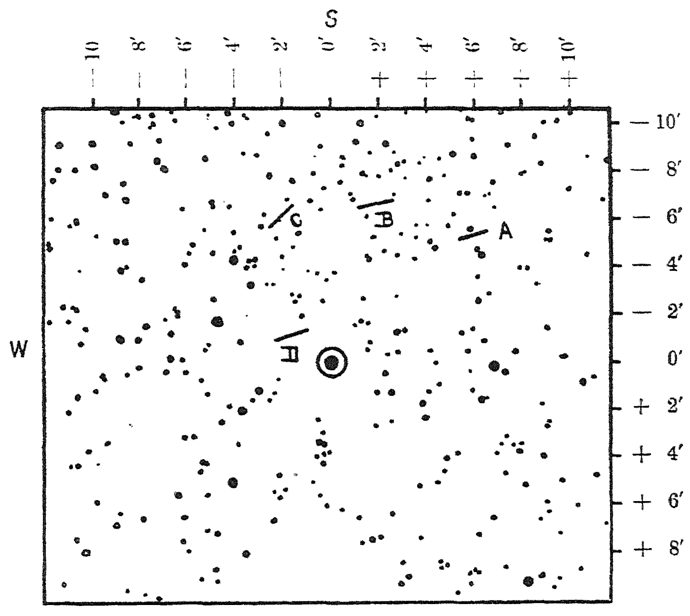

FIG. 3.—Diagram showing changes in position in the condensations as determined by the later observations at the Lick Observatory on November 7-8.

The note then goes on, "such an exceptional velocity as is here indicated leaves little doubt of the intimate connection of this nebulous matter with the Nova and its outburst. It is, perhaps, too soon to say just what bearing the foregoing observations will have upon the explanation

of the phenomena connected with new stars. It would seem, however, that such great velocities pointed rather to a violent collision of some sort than to an outburst within a dark and comparatively cool body; but whether a collision of a solid body with another, or the passage of a solid body through a gaseous nebula or a swarm of meteorites is uncertain."

It appears to me that the full significance of the recent observations has not been grasped by those who have commented upon them. It seems difficult to imagine that most of the new stars, like the bright-line stars and bright-line nebulæ, are *not* at the distance of the Milky Way as well as in its plane. If this be so, then this distance is enormous. Let us assume—the assumption is a moderate one—that it is represented by a parallax of half a second, and see how it works out on the two-minute squares marked in the diagrams.

At the Nova situated at such a distance, 1 minute of arc represents about 120 times the sun's distance from the earth.

The apparent movement of the condensations is stated to have been $1\frac{1}{2}$ minutes in 48 days, say, approximately, 1 minute in a month, say, again, four times the distance of the sun in a day.

I do not say that such rapid translations of masses of matter are impossible, certainly there are no precedents for them; but my point is that there is absolutely no necessity for the assumption of such movements, and that the apparent change of position of these condensations can be explained otherwise than by movement. Indeed, such an explanation is not hard to seek when the meteoritic theory of new stars is closely considered in all its aspects. It is a well-known fact that the majority of new stars that have been recorded in more modern times, when the spectroscope has been available for their study, have ended by becoming nebulæ. The meteoritic theory explains the appearance of a new star by the interpenetration of two or more swarms of meteorites, a nebula being the representative of an ordinary great swarm, a comet near the sun being a representative of a small one disturbed by tidal action. The appearance of a new star is produced by the luminosity depending upon the celestial clashing. It is not difficult to conceive a system of several swarms of meteorites all performing their individual orbits, and so long as no two systems collide, the whole system will be invisible; but should a collision occur they will at once become visible, and the more violent the collision the brighter will be the light and the greater will be the luminosity of the "new star" which makes its appearance to chronicle the event.

Now suppose a nebula invaded, not by one, but by many swarms, under such conditions that the collision effects vary very greatly in intensity. In the present case the most violent one we began to know about some months ago; it constitutes Nova Persei. The least violent ones occurring in other parts of the disturbed nebula, almost immeasurably removed, *i.e.* more than 700 solar distances away, we only learn of from the recent photographs. The disturbances they chronicle are so feeble that to see the effect of them 7 hours' exposure with a 3-foot reflector are necessary, hence they soon die out; while they are dying other disturbances in other parts of the nebula arise. There is probably, therefore, no question of motion from place to place, we are dealing simply with different disturbances occurring in different places.

It is impossible to think that the great nebula which has now been photographed while the new star is still in being did not exist there a few months ago; and it is important, further, to remark that the nebulous matter already photographed in the region round the Nova is very probably only a portion of the actual amount of matter existing there, and that if the disturbances continue, more of the remaining portion may become visible. This, in fact, seems already to have been established, for Ritchey found later that the nebula "seems expanding in all directions." At the same time it may be stated that Campbell notes that the condensation D has remained unchanged, while there has been a further "movement" in the case of A and B, the "movement" of C being doubtful. There seems little doubt that later photographs will throw light on this question, but a matter to be regretted in this connection is that no photographs are available for the period during which the well-marked variability of the Nova was observed. These occasional outbursts of light were, we can now imagine, due to other disturbances of the nebula intermediate in intensity between that which caused the Nova itself and the other exceedingly faint ones now being photographed.

One important conclusion can, at any rate, be deduced from the Lick photographs, and that is that such explanations as explosions on solid globes, worlds on fire, volcanic eruptions, &c., must be considered less probable now that a great nebula is shown to be associated with many disturbances of very varying intensities. Formerly we had to wait for the death of a new star before the appearance indicating the existence of a nebula was manifested, and hence arose the idea that a star changed into a nebula, thus reversing the ordinary process of evolution.

NORMAN LOCKYER.

NOTES.

THE four Nobel prizes were distributed at Stockholm on Tuesday evening before a distinguished audience, among whom were the Crown Prince and other members of the Royal family o Sweden. Each prize was of the value of 200,000 francs. The prize for medicine was awarded to Dr. E. A. Behring, the prize for chemistry to Prof. J. H. van 't Hoff, the prize for physics to Prof. W. K. Röntgen, and the prize for literature to M. Sully Prudhomme.

IT is officially announced that the Board of Admiralty have received with much regret the resignation by Sir William H. White, K.C.B., F.R.S., in consequence of ill-health, of the appointment of Director of Naval Construction, which he has filled since 1885 with great distinction. They have appointed as his successor Mr. Philip Watts, F.R.S., who has held during the same time the post of director of the war shipbuilding department of Messrs. Sir William Armstrong, Whitworth and Co., Ltd., and naval architect to the company. Mr. Watts has done much original scientific and experimental work in connection with investigations of the stability of ships and floating bodies, the oscillations of ships in still water and amongst waves, and the propulsion and manœuvring powers of ships.

THE Berlin correspondent of the *Times* states that the estimates for the German Army include a vote for the new military technical college which the Government will open in the course of next year. The necessity for some such institution has been impressed upon the military authorities by the advancing scientific requirements of modern warfare, which are now too numerous and too varied to be provided for adequately by the resources at the command of the existing Staff College. There are branches of technical knowledge which, although they cannot strictly be classed as military, are nevertheless indispensable for the soldier. Among such subjects are steam-power, electricity, mechanics, the construction of boats and bridges, and the establishment of means of communication. In recognition

of this fact the college which is shortly to be opened will have for its objects the extension of general technical knowledge in the Army and also the special technical training of engineer officers, as well as of those officers who desire to prepare themselves there for a career in the railway, ballooning and other special departments of the service. It is expected that the college will be opened on October 1, 1902. The ordinary annual expenses are estimated at 300,000 marks.

AMONG the lecture arrangements at the Royal Institution, before Easter next year, we notice the following:—Prof. J. A. Fleming, six lectures (adapted to young people) on waves and ripples in water, air and æther Dr. A. Macfadyen, six lectures on the cell, its means of offence and defence, immunity; Mr. W. N. Shaw, two lectures on the temperature of the atmosphere, its changes and their causes; Prof. E. B. Poulton, two lectures on recent researches on protective resemblances, warning colours and mimicry in insects; Dr. A. S. Murray, three lectures on recent excavations at Delphi and in the Greek Islands; six lectures on some electrical developments, by Lord Rayleigh. The Friday evening meetings will commence on January 19, when Lord Rayleigh will deliver a discourse on the interference of sound.

A CIRCULAR just issued announces that the Andrew Carnegie research scholarship or scholarships, of such value as may appear expedient to the Council of the Iron and Steel Institute from time to time, will be awarded annually, irrespective of sex or nationality, on the recommendation of the Council. Candidates, who must be under thirty-five years of age, must apply, on a special form, before the end of March to Mr. B. H. Brough, the secretary of the Institute. The object of this scheme of scholarships is not to facilitate ordinary collegiate studies, but to enable students who have passed through a college curriculum or have been trained in industrial establishments to conduct researches in the metallurgy of iron and steel and allied subjects, with the view of aiding its advance or its application to industry. There is no restriction as to the place of research which may be selected, whether university, technical school or works, provided it be properly equipped for the prosecution of metallurgical investigations. The appointment to a scholarship will be for one year, but the Council may at their discretion renew the scholarship for a further period instead of proceeding to a new election. The results of the research will be communicated to the Iron and Steel Institute in the form of a paper to be submitted to the annual general meeting of members, and if the Council consider the paper to be of sufficient merit, the Andrew Carnegie gold medal will be awarded to its author.

THE death is announced of the Rev. Hugh Alexander Macpherson, of Glendale, at the early age of forty-three. Mr. Macpherson was an authority on the fauna of the lake country, and had published an elaborate work on the subject, "A Vertebrate Fauna of Lakeland, including Cumberland and Westmorland, with Lancashire North of the Sands." He was also the author of a book entitled "British Birds."

THE "Association Internationale des Botanistes," founded in August at Geneva, having purchased the *Botanisches Centralblatt*, will continue it as the organ of the Association. It will be published by Messrs. Brill, of Leyden, and the first number will be issued on January 1, 1902. The journal will appear weekly and will contain abstracts of all important publications on botanical subjects. The cooperation of a large staff of highly competent special editors in various countries has been secured, and the abstracts will be published in English, French or German. The annual subscription of members of the Association is 25*s*., and they will receive the journal post free. Applications for membership may be made to Dr. J. P. Lotsy, Oude Rijn, 33A, Leyden, Holland, who acts as the editor-in-chief. A feature of the journal will also be a very full list of the current publications in the science. In order to assist the editor, authors of botanical publications are invited to send copies of their works to him, or to the special editor in their own branch, in their country. The special editors for Great Britain are as follows:—Algæ, Miss Barton, British Museum (Nat. Hist.); Fungi, Mr. Massee, Royal Gardens, Kew; Archegoniatæ, Mr. A. Gepp, British Museum (Nat. Hist.); Phanerogams, Mr. Daydon Jackson, 21, Cautley Avenue, Clapham Common, S.W.; Cytology, Prof. Farmer, Roy. Coll. of Science, S. Kensington; Physiology, Prof. Vines, Headington Hill, Oxford; Morphology, Dr. W. H. Lang, University, Glasgow; Palæontology, Prof. Scott, Old Palace, Richmond, Surrey.

A NEW form of stereoscopic fluoroscope, worked out by Mr. E. W. Caldwell, is described by him in the New York *Electrical Review* for November 16. The method employed is the same as that first brought forward by Dr. McKenzie Davidson, but some modifications are introduced which, it is said, make it more easy to operate. Instead of using two different tubes as the sources of Röntgen rays, a single tube is used into which two antikathodes are sealed. The tube is excited by an alternating current by connecting it to the secondary coil of a transformer the primary of which is connected to the street mains through a Caldwell liquid interrupter; when a direct-current supply only is available, a small rotary converter is used to give an alternating current. The antikathodes are thus alternately sources of Röntgen rays, and the shadows these cast on the fluoroscope screen are viewed through a rotating shutter which only allows the right eye to see the shadow from one antikathode and the left eye that from the other. The shutter is rotated by a synchronous motor supplied from the same source of current as the X-ray tube. The speed of rotation is such that 7200 shadows are cast per minute, 3600 of which are visible to the right eye of the observer and the alternate 3600 to his left eye; the result is that the radiograph is seen as a continuous image showing the shape and space relations of the object examined. The fluoroscope screen and rotating shutter, with its motor, are mounted together in a portable form in order that in surgical cases they may be conveniently adjusted to suit the case of the patient.

THE Royal Meteorological Society has published in its *Quarterly Journal* an account of the bequest made to it by Mr. G. J. Symons of such of his books, pamphlets, maps and photographs, copies of which were not already possessed by the Society, and exclusive of works specially relating to rainfall. As a result, some 6200 books and pamphlets and 900 photographs have passed into the library of the Society, including some valuable works on rainfall to which Mr. H. Sowerby Wallis generously yielded his prior claim. In addition, Mr. Symons bequeathed to the Society various medals, &c., and a sum of 200*l*., which has been utilised in providing accommodation for this valuable legacy. Mr. Symons's library was almost entirely meteorological; many of the volumes were exceedingly scarce and of very early date, and he endeavoured to procure a copy of each edition published. Nine of the works belong to the fifteenth century, 128 to the sixteenth and 214 to the seventeenth centuries. One of the earliest daily records of weather kept in London (1668–1689) is contained in a work entitled "Nauticum Astrologicum: or the Astrological Seaman," by John Gadbury (London, 1710). Another early record in London is "A Meteorological Journal kept in Paternoster Row" (1786–1792), by W. Bent. Mr. Symons's note is, "Excessively scarce. I never saw or heard of another copy." A later publication, carrying the

observations down to 1800, and containing a summary of the previous observations, is not so scarce. Although not included in the bequest, the Society wisely obtained by purchase a bibliography compiled by Mr. Symons containing about 60,000 titles of meteorological and kindred subjects.

AN International Exhibition of Automobiles was opened at Paris on Tuesday. Among the exhibits of scientific interest are steerable balloons and motors to drive them. The cigar-shaped balloon "Ville de Paris," which M. Deutsch proposes to try next spring, is shown, and also a steerable military balloon invented by Major Renard.

PROF. G. VICENTINI has communicated to the *Atti* of the Venetian Institution a paper on the supposed efficacy of canon-firing in preventing hailstorms. In this paper the author briefly reviews the work of the second International Congress held at Padua, and his general conclusion is that the matter requires to be studied in a more scientific and statistical manner than has been hitherto done. For this purpose it may be desirable on account of expense to restrict the investigation to a limited region, but in the absence of more exact investigations it is thought that the experiments hitherto carried out can be hardly regarded as conclusive.

WE received a few days ago the Report, dated March 1901, of the International Association for Promoting the Study of Quaternions and Allied Systems of Mathematics. From the address of the president, Prof. C. J. Joly, of Dublin, we learn that the Association was founded about the year 1900, at the instigation of Mr. S. Kimura, of Japan, and Dr. P. Molenbroek, of the Hague, and Sir Robert Ball was its first president. The society proposes to publish a bibliography of the subject, and a report on the position of quaternions and allied branches of mathematics in the curricula of universities and colleges throughout the world is also projected.

WE have received from the author, Mr. G. W. Cole, a copy of a pamphlet entitled "Bermuda and the *Challenger* Expedition," being a bibliography of the results obtained by that expedition at and near Bermuda. Owing to the establishment of a biological station, each year witnesses the arrival in the islands of an increasing number of zoologists, and it is for their use that this useful pamphlet has been chiefly compiled.

THE observations of Herr E. Wasmann on the relations subsisting between the staphilinid beetles dwelling parasitically (or commensurally) in the nests of ants and termites are already classic. The subject is further elaborated in a paper (the first of a series) which appears in the *Biol. Centralblatt* for November, in which the author suggests that in some of these parasites we have instances of the actual evolution of species going on before our eyes.

OUR contemporary *Die Umschau*, of December 7, contains an interesting summary, by Dr. F. Knauer, of recent investigations —especially those of E. Wasmann—connected with the life-history of ants and termites, particular attention being directed to those insects living in commensalism in their nests, and the plants they cultivate. Attention is first directed to the so-called "crippled" or "pseudogynous" ants of certain species, which have the head and abdomen of a worker and the body of a female. Following this, the author refers to the curious circumstance that not only do the beetles living in commensalism with ants show an extraordinary enlargement of the abdomen, but that the same feature characterises the recently-discovered flies of the genus Termitoxenia. The paper concludes with a notice of the funguses and other plants cultivated by ants.

THE new editions of Darwin's "Descent of Man" and "Origin of Species" which have recently been published by Mr. John Murray are the most remarkable specimens of cheap and authoritative scientific literature which have come under our notice. Either of the books named can now be obtained in the form of a well-printed and neatly-bound volume for half-a-crown, and a popular edition of the "Origin of Species" has been published at the price of one shilling. No one interested in the great problems of natural history need, therefore, be without the two works which determined the direction of inquiry in the last century and still exert a profound influence upon biological thought. It is worth while to remind naturalists that though the copyright of the "Origin of Species" has now expired, only the imperfect edition can be reprinted without the authority of the author's executors. The only complete and authorised edition is that published by Mr. Murray.

THE Report for the year 1900 of the Botanic Garden and Domains, Sydney, New South Wales, by the director, Mr. J. H. Maiden, shows steady work in the improvement of the Gardens and the increased efficiency of the herbarium and library. The details are chiefly of local interest.

WE have received from the U.S. Department of Agriculture (Division of Botany) two interesting pamphlets (*Bulletins* Nos. 27 and 28): Seeds of Commercial Salt-bushes—*i.e.* species of Atriplex—grown as forage-plants in the arid regions of the West, by Mr. G. N. Collins; and The Chayote, a Tropical Vegetable, by Mr. O. F. Cook. The chayote or tayote, *Sechium edule*, a member of the Cucurbitaceæ, is better adapted for a tropical climate than most herbaceous plants. It has been grown from time immemorial by the aborigines of South America for its succulent fruit, but, like so many cultivated plants, is unknown in the wild state.

THE *Journal* of the College of Science of the Imperial University of Tokyo (vol. xv. part iii.) contains several interesting botanical articles, mostly in German; among the rest: On the organisms concerned in the fermentation of the Japanese spirit "awamori," by Mr. T. Inui, which is attributed mainly to a new species, *Aspergillus luchuensis*, accompanied also by *Aspergillus perniciosus*, sp.n., *Saccharomyces Awamori*, sp.n., and *S. anomalus*; on the transpiration of evergreen trees in winter, by Mr. S. Kusano; both transpiration and assimilation are continued through the winter in the climate of Tokyo; on the action of cupric sulphate on plants, by Mr. N. Hattori; and on the more important fibre-plants of Japan, by Mr. K. Saito.

THE first instalment of the second edition of Prof. van 't Hoff's "Vorlesungen über theoretische und physikalische Chemie," dealing with chemical dynamics, has been published by Messrs. F. Vieweg und Sohn, Brunswick. This is the part of the work which has been translated into French and English and already noticed in the review columns (vol. lix. pp. 458, 557, 1898).

THE Polygraphisches Institut of Zürich has just issued the first and second parts of a series of plates and descriptive text entitled "Arboretum Amazonicum." The author of this iconography is Dr. J. Huber, head of the botanical section of the Museum of Natural History and Ethnography at Para, and the work will be completed in ten parts. When the whole of the parts have been received a review of their contents will appear in these columns.

A SHORT address on the progress of physics during the nineteenth century, recently delivered before the St. Louis Academy of Sciences by Prof. F. E. Nipher, has been issued in the *Transactions* of the Society (vol. xi. No. 6). He remarks, in concluding his survey, "If the history of the last century has taught us anything, it has established the practical or commercial value of research in pure science. It is from such work that all of the great achievements have directly

come. And whenever any people forgets the source from which these great things have come, and allows engineering to supplant science, that people is on the way to the civilisation of China."

MESSRS. MARION AND CO. have just commenced the publication of reproductions of a fine series of photographs of "The Empire: its Cities, Palaces and Buildings." The views can be obtained in half-tone process prints or reproduced by collotype process. In the collection of pictures of "Famous Buildings of London," which forms one number of the series, we notice views of the Imperial Institute and the British Museum. The Natural History Museum deserves to be included, but there are few other fine buildings devoted to scientific research and education in London. Fine buildings do not necessarily make fine work, but they facilitate it and show in what regard the nation holds those who contribute to its scientific and industrial progress.

ABSTRACTS of the papers read before the Royal Society of New South Wales appear regularly among our reports of societies and academics. The volume of *Proceedings* containing the complete papers read before the Society in 1900 has now been received, and calls for a note of admiration. Among the subjects dealt with are the sun's motion in space, and the volumes of solids as related to transverse sections, by Mr. G. H. Knibbs; several papers on eucalyptus oils, by Mr. H. G. Smith; customs of Australian aborigines, by Mr. R. H. Mathews, Mr. W. J. Enright and Miss M. M. Everitt; the crystalline structure of some gold, silver and copper nuggets, by Prof. A. Liversidge, F.R.S.; and an experimental investigation of the strength of brickwork when subjected to compressive and transverse stresses, by Prof. W. H. Warren and Mr. S. H. Barraclough.

THE additions to the Zoological Society's Gardens during the past week include a South Albemarle Tortoise (*Testudo vicina*) from the Galapagos Islands, a Conical Eryx (*Eryx conicus*) from India, deposited; a Shag (*Phalacrocorax graculus*), European, purchased; an Axis Deer (*Cervus axis*), born in the Gardens.

OUR ASTRONOMICAL COLUMN.

NEW VARIABLE STARS.—The following newly-detected variables are announced in the *Astronomische Nachrichten* (Bd. 157, No. 3751):—

94, 1901, *Cygni*.—

A.G. Bonn (B.D. $+41°\cdot4114$)

$$\left.\begin{array}{l}\text{R.A.} = 21\text{h. } 17\text{m. } 42\text{s.}\\ \text{Decl.} = +41°\ 51'\cdot8\end{array}\right\}(1875\cdot0)$$

Herr Fr. Deichmuller states that there is a variation of about half a magnitude; the times are not sufficiently continuous to deduce a value of the period.

95, 1901, *Pegasi*.—Dr. T. D. Anderson announces variability in the star B.D. $+24°\cdot4462$, whose position is

$$\left.\begin{array}{l}\text{R.A.} = 21\text{h. } 37\text{m. } 56\text{s.}\cdot0\\ \text{Decl.} = +24°\ 20'\cdot6\end{array}\right\}(1855\cdot0)$$

The star is sometimes about 10 magnitude, but at intervals becomes much fainter.

96, 1901, *Cygni*.—Mr. Stanley Williams finds from photographs taken with a 4·4-inch portrait lens that variability exists in the star B.D. $+29°\cdot4231$.

$$\left.\begin{array}{l}\text{R.A.} = 20\text{h. } 49\text{m. } 2\text{s.}\cdot1\\ \text{Decl.} = +29°\ 51'\cdot8\end{array}\right\}(1855\cdot0).$$

The following variations are recorded:—

1901 Sept. 21 ... 10·81 mag.		1901 Nov. 1 ... 9·88 mag.
Oct. 7 ... 10·26 ,,		,, 3 ... 10·47 ,,
,, 14 ... 9·79 ,,		

These indicate a maximum of 9·7 magnitude on 1901 October 21. The star was invisible on plates taken on 1899 October 6 and 9, 1900 October 26, 27 and November 15, so that it must have been fainter than 12 magnitude. The period is at present uncertain.

BRIGHT METEOR OF DECEMBER 4.—A brilliant meteor was seen by several observers shortly after five o'clock in the evening of Wednesday in last week, December 4. Prof. J. P. O'Reilly, writing from Dublin, says:—"At 5h. 11m. p.m. this evening I saw in the south-eastern sky a brilliant meteor, which appeared at a point about 30° above the horizon and had a course about equal in length to the belt of Orion. The fore part was brilliant bluish-white, the after part red sparks. The direction of movement made with the horizon an angle of about 60° to 65°, the inclination of the line of movement being to the south. There were no stars visible by which I could more distinctly fix its position."

Mr. C. Waterer (Highfield, Northdown Avenue, Margate) and two friends saw the meteor while walking towards Kingsgate, near Margate. He remarks, "The trail remained visible to us all for some seconds. We were then looking west, and its direction was approximately from north to south. The time by my watch was 5.35 p.m."

"COMPANION TO THE OBSERVATORY," 1902.—This almost indispensable handbook for the practical observer has recently been issued for the coming year. The contents and arrangement are similar to those of previous issues. A small addition which will be useful to spectroscopists is the list of spectroscopic double stars, with their periods so far as is at present known.

THE VARIATIONS IN THE MAMMALIAN EYE.[1]

DR. LINDSAY JOHNSON'S work, in the investigation of the deep anatomy of the mammalian eye as displayed by the ophthalmoscope, has been of a very extensive and persevering, not to say of a very adventurous character; and the volume before us, containing his contribution on the subject to the *Transactions* of the Royal Society, represents no more than a fraction of the material which he has collected, and which he intends, we understand, one day to publish. Not the least interesting part of it will be that which will deal with his methods, with the perils occasionally attendant upon them, and with the contrivances by means of which a living lion and a living whale were compelled to submit themselves to ophthalmoscopic examination. Mirror in hand, Dr. Johnson has not only visited the zoological gardens of many countries, but also the native haunts of many wild creatures; and in the book before us some of his discoveries are displayed in twenty-six plates, containing fifty coloured drawings of eyegrounds, beautifully finished and exquisitely reproduced in chromo-lithography, and in three plates with drawings in black and white, showing variations in the forms of persistent hyaloid artery, rudimentary forms of pecten, and different types of the appendages which are found on the pupillary margins of many of the ungulata.

The general result of Dr. Johnson's observations is to show the existence among mammalia of very wide differences in two respects; first, as regards the vascular supply of the optic nerve and retina; secondly, as regards the presence, coloration and pigmentation of the tapetum.

With regard to the first of these, it may be said that the general type presented by the human eye, that is, the presence of a central artery and vein of the retina, finding entrance and exit among the fibres of the optic nerve, and constituting a practically closed and complete retinal circulation, is more or less preserved in monkeys, lemurs, the carnivora, some of the ungulata, some of the rodentia, and some marsupialia, but is either absent or concealed by tapetum in the Australian fruit-bat, the Indian rhinoceros, Burchell's zebra, the American tapir, the African elephant, the Canadian beaver, the chinchilla, the guinea-pig, the Central American agouti, the Brazilian porcupine, the hairy armadillo, the wombat, the squirrel-like phalanger and the echidna; while among these latter animals there are great differences in the blood-supply of the optic disc itself, which in some of them, as in the Indian rhinoceros and the hairy armadillo, is of a dead white like the whiteness of atrophy in the human subject; while in others, as the zebra, it is abundantly vascular, and is surrounded by a radiation of small

[1] "Contributions to the Comparative Anatomy of the Mammalian Eye, chiefly based on Ophthalmoscopic Examination." By George Lindsay Johnson, M.D., F.R.C.S. From the *Philosophical Transactions* of the Royal Society of London for 1901. Pp. 82, with 26 plates in colour and 4 in black and white. Price 21s.

vessels extending a short distance from its periphery. In many animals the optic disc is deeply excavated up to its margins, and resembles that of chronic glaucoma in the human subject, a state of which the best examples are furnished by the seal, the serval, and the red and white flying-squirrel. The condition presented by the rabbit, in which some of the fibres of the optic nerve carry their sheaths through the lamina cribrosa to form an opaque patch on the retina, is met with in many other animals, but with much variety in the depth and distribution of the opacity.

The coloration of the tapetum varies greatly in different animals; and Dr. Johnson calls particular attention to his drawing of the eye of Monteiro's galago, in which the general yellow of the central part of the fundus is surrounded by a zone of pigmentation precisely resembling what is called "pigmentary retinitis" in the human subject. Dr. Johnson inclines to the belief that the affection so described is not really a disease, but rather a reversion to a type of structure which is the rule in night-seeing animals.

It is impossible to withhold a tribute of admiration from the perseverance with which Dr. Johnson has conducted his researches, or from the beauty of the drawings in which the results of his observations are displayed; but it is for the moment necessary to retain a suspended judgment with regard to the value of his work. As an observer he stands alone; and the drawings which he has made, notwithstanding their great and obvious merit, are as yet mere personal records, liable, it may be, to some disturbing influence from a personal equation. It is much to be regretted that photography has not been made available for taking pictures of the eyeground from which this element of uncertainty would be removed. Even if this were done, it would still be necessary to determine, by more extended portraiture, whether the conditions described are normal ones or subject to variation in individuals. We cordially welcome Dr. Johnson as a pioneer, and we feel sure that he will fully appreciate the necessity for caution in accepting his conclusions.

THE COAL-TAR COLOUR INDUSTRY IN GERMANY AND ENGLAND.

WITH the object of ascertaining our present and future prospects in the chemical trade of the world, Mr. A. G. Green, in a paper read before the section of chemistry of the British Association, at this year's meeting, described the relative progress of the coal-tar industry in England and Germany during the past fifteen years. The council decided to print the paper *in extenso*, and the subjoined particulars extracted from it convey an idea of what England has lost by the neglect of the scientific foundations of an industry. The paper may be regarded as a sequel to one by Prof. Meldola published in NATURE fifteen years ago (vol. xxxiv. p. 324), when the position of the industry in Germany and England was described, and a warning was given to British manufacturers.

The exports of coal-tar colours manufactured in England have fallen from 530,000*l.* in 1890 to 366,500*l.* in 1899. Comparing these figures with the rapidly increasing export trade of Germany, it is seen that whereas formerly the English export trade in artificial colours was about one-quarter that of Germany, it does not now amount to a tenth part. It is therefore only too apparent that we have had but little share in the great increase which this industry has experienced during the past fifteen years, and that we have not even been able to supply the expansion in our own requirements. In order to ascertain what proportion of our own needs we at present furnish, I am able to lay before you the following interesting figures, which have been kindly supplied me by the Bradford Dyers' Association and the British Cotton and Wool Dyers' Association, who together form a very large proportion of the entire dyeing trade:—

Colouring Matters used by Bradford Dyers' Association.

English, 10 per cent.; German, 80 per cent.; Swiss, 6 per cent.; French, 4 per cent.

Colouring Matters used by British Cotton and Wool Dyers' Association.

Aniline Colours.—English, 22 per cent.; foreign, 78 per cent.

Alizarine Colours.—English, 1·65 per cent.; foreign, 98·35 per cent.

The *English Sewing Cotton Company* have also very kindly supplied me with a detailed analysis of their consumption, from which it appears that out of a total of sixty tons of colouring matters and other dyeing materials derived from coal tar, only 9 per cent. were of English manufacture.

The following table of statistics of the six largest German firms gives a fair picture of the present dimensions of the industry in that country (*vide* next page).

The joint capital of these six firms amounts to at least $2\frac{1}{2}$ millions. They employ together about 500 chemists, 350 engineers and other technologists, 1360 business managers, clerks, travellers, &c., and more than 18,000 workpeople. Compared with such figures as these the English colour manufacture assumes insignificant proportions. The total capital invested in the coal-tar colour trade in England probably does not exceed 500,000*l.*, the total number of chemists employed cannot be more than thirty or forty, and the number of workmen engaged in the manufacture does not amount to more than a thousand.

A similar relative proportion is maintained in the number of patents for new colouring matters and other coal-tar products taken by the English and German firms, as is shown by the following table:—

Comparison of Number of Completed English Patents for Coal-tar Products taken during 1886–1900 by six largest English and six largest German Firms.

German Firms.	
Badische Aniline Works	179
Meister, Lucius, & Brüning	231
Farbenfabriken Bayer & Co.	306
Berlin Aniline Co.	119
L. Cassella & Co.	75
Farbwerk Mühlheim, Leonhardt & Co.	38
Total of six German firms	948
English Firms.	
Brooke, Simpson, and Spiller	7
Clayton Aniline Co.	21
Levinstein	19
Read, Holliday, & Co.	28
Claus & Ree	9
W. G. Thompson	2
Total of six English firms	86

Nor does the potential loss which we have sustained by our inability to take advantage of a growing industry represent the sum total of our losses. The new colouring matters, made almost exclusively in Germany, have in many cases been introduced as substitutes for natural products, which were staple articles of English commerce. Madder and cochineal have been replaced by alizarine and azo-scarlets, the employment of many dyewoods has greatly decreased, whilst at the present moment logwood and indigo are seriously threatened. Regarding the indigo question so much has been written that I do not propose to occupy space in its further discussion, but will only point out that the complete capture of the indigo market by the synthetic product, which would mean a loss to our Indian dependencies of 3,000,000*l.* a year, is regarded by the Badische Company as so absolutely certain that, having already invested nearly a million pounds in the enterprise, they are at present issuing 750,000*l.* of new debenture capital to provide funds to extend their plant for this purpose! In the last annual report of the company they say: "As regards plant indigo, the directors are prepared and determined to meet this competition in all its possible variations in value. Much strange matter has been published in India as to improvements in the cultivation and preparation of natural indigo, but the illusions of the planters and indigo dealers are destined to be dispelled before facts, which, although they are not known to them, will make themselves more felt the larger the production of artificial indigo becomes."

Besides the loss of material wealth which the neglect of the coal-tar trade has involved to the country, there is yet another aspect of the question which is even of more importance than the commercial one. There can be no question that the growth in Germany of a highly scientific industry of large and far-reaching proportions has had an enormous effect in encouraging and stimulating scientific culture and scientific research in *all*

Position of the Six Largest Colour Works in Germany in Year 1900.

—	Badische Aniline Works.	Meister, Lucius and Brüning.	Farbenfabriken Bayer and Co.	Berlin Aniline Co.	Cassella and Co.	Farbwerk Mühlheim, Leonhardt and Co.	Total of six largest firms.
Capital	£1,050,000	£833,000	£882,000	£441,000	Private concern	£157,000	About £2,500,000
Number of Chemists	148	120	145	55			About 500
Number of engineers, dyers, and other technologists	75	36	175	31	60	450	About 350
Commercial staff	305	211	500	150	170		About 1,360
Workpeople	6,485	3,555	4,200	1,800	1,800		About 18,260
Dividends in 1897	24 per cent.	26 per cent.	18 per cent.	12½ per cent	Not known	9 per cent.	—
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branches of knowledge. It has reacted with beneficial effect upon the universities, and has tended to promote scientific thought throughout the land. By its demonstration of the practical importance of purely theoretical conceptions it has had a far-reaching effect on the intellectual life of the nation. How much such a scientific revival is wanted in our country the social and economic history of the past ten years abundantly testifies.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

CAMBRIDGE.—An interesting ceremony took place on Saturday last, when a portrait of Prof. G. D. Liveing, painted by Sir John Reid, president of the Royal Scottish Academy, was presented to St. John's College as a mark of recognition of Prof. Liveing's services to science. The portrait was provided by subscription, and the funds obtained will also enable a bronze bust of Prof. Liveing to be placed in the Chemical Laboratory at Cambridge. The Vice-Chancellor (Dr. Ward, Master of Peterhouse) presided at the meeting of subscribers, and the attendance included the Lord Lieutenant, Sir John Gorst, Sir Richard Jebb, the Masters of Trinity, St. John's, Clare, Jesus, Christ's, and Downing, Profs. Sir George Stokes, E. C. Clark, J. Dewar, W. J. Lewis, A. R. Forsyth, J. Westlake, J. J. Thomson, J. A. Ewing, W. W. Skeat and J. S. Reid, besides many other resident members of the Senate.

PRINCIPAL RÜCKER, F.R.S., will distribute the prizes and certificates to students of the South-Western Polytechnic, Chelsea, to-morrow evening, December 13. The chair will be taken by Mr. Sidney Webb.

PROF. EDGAR CROOKSHANK, who lately resigned the active duties of the chair of comparative pathology and bacteriology in King's College, London, which he occupied for fifteen years, has had the title of Emeritus Professor conferred upon him by the Council in consideration of his long and brilliant services.

THE St. Petersburg correspondent of the *Times* states that the Minister of Public Instruction has made a decree expelling all the first-year students at the Kharkoff Veterinary Institute for insulting the professor of chemistry at that college. The reason for this action on the part of the Minister is the fact that on November 28 the first-year students sent a signed request to the professor of chemistry that he should resign his chair on the ground that his teaching was unsystematic and obscure. The decree adds that the professorial staff were agreed that the charge against their colleague was without foundation.

THE *British Medical Journal* states that the municipality of Hamburg has adopted a scheme by which all the scientific institutions of the city are to be grouped together into a university. The directors of these institutes and the lecturers, who have the title of professors, will form the professorial college, which every year will elect its own president. It will also be the duty of the college every year to draw up a programme of lectures and practical courses. The programme for the current winter semester includes courses by 117 lecturers. This movement is a step towards the foundation of a fully-equipped university in Hamburg, a project which has long been under consideration.

AFTER a meeting of the U.S. Cabinet on Tuesday it was stated that the President had received a communication from Mr. Carnegie on the subject of the creation of a fund for the extension of higher education. The amount said to have been offered is ten million dollars. It is understood (says the *Times* correspondent at Washington) that the proposal does not involve the establishment of university buildings at Washington, but that it is intended rather to place a fund in the hands of Government trustees, from which the expenses of deserving students may be paid for the encouragement of original research at home or abroad. It is believed that the proposal has not yet taken concrete form, except as regards its general terms and the amount of the gift. The President will consult with members of Congress with regard to the proposed gift before making its terms public.

MR. HANBURY, President of the Board of Agriculture, distributed the prizes at the Derby Municipal Technical College last week, and gave an address upon some aspects of technical education. In the course of his address he remarked that he believed that partly where the United States and Germany had the advantage of England was not in the technical education of their working classes, but among the great leaders of commerce and industry. Commercial education must spread from the top to the bottom. They wanted to have commercial instincts and business capacity instilled into their leading commercial men, even up to the universities themselves. England was far behind America in that respect. Twenty years ago there was only one college of the kind to which he referred in the States, and that was in Pennsylvania; now there were at least nine or ten universities in the Union which were giving that commercial education to the leaders of the country's commerce and industry. It was, unfortunately, the fact that they were lacking in a good system of secondary education. He hoped something would be done in the matter in the next session of Parliament. The foundation for the work of technical schools was a good, sound education, which could only be obtained in the secondary schools. This was the reason why at the present moment they did not find in technical schools those advanced students and day scholars which he hoped, under the new system, they would find flocking into them.

THE movement in favour of reformed methods of mathematical teaching can be assisted by discussions at provincial scientific societies and university centres. A discussion of this kind took place at the meeting of the Royal Glasgow Philosophical Society, held on December 6, Prof. Gray being in the chair, when the subject of the teaching of mathematics to engineers was opened by Prof. Barr. It was remarked by him that the engineer uses mathematics as a tool, and it is not essential for the man who uses tools to manufacture them. He did

not think it necessary that strict mathematical proofs should be given for everything. An engineer learned physical constants, and physical data might be taken for granted. He believed that the education of the engineer in mathematics would gain and not lose if instead of strict proof there was more of illustration. Prof. Barr gave the calculus an important position, but expressed his desire for the portable formulæ advocated by Prof. Perry. Dr. H. S. Carslaw, in the course of some remarks, said if teachers in schools would anticipate the teachers in the colleges by using graphical methods they would not hear mathematics spoken of as killing thought and destroying education. At present Euclid is given far too prominent a position in school work, with the result that algebra and trigonometry suffer. Prof. G. A. Gibson expressed general agreement with the views of Prof. Barr. He would not, however, insist too much on doing away with logical demonstration. The foundation for the teaching of mathematics should be laid at school, and he complained that two years of a schoolboy's life were worse than wasted by the enormous amount of rules which he had to commit to memory, which were of no intellectual interest and which he was almost certain to forget.

THE Education Committee of the General Medical Council presented a second report on the steps to be taken for the improvement of preliminary examinations at the meeting of the Council last week. Sir John Batty Tuke, chairman of the Committee, in presenting the report explained that in November, 1898, the Education Committee was asked to report when, in its opinion, it would be practicable to raise preliminary examination to the senior and higher standards. In June, 1899, the Committee reported, after consultation with a large number of educational authorities, that it would be better if educational experts were appointed to review the circumstances of all examinations. Experts were appointed, and in December, 1899, the Committee submitted a report, along with a report of the experts, who held that it was impossible to raise the standard to the senior or higher grade in the present condition of secondary education in Great Britain. Thereupon the experts were asked to state reasons for the belief. In March, 1900, they gave these reasons, and the Committee was then enabled to work upon certain fixed principles. The principal difficulty met with was how to produce a rise in the character of examinations in reality, a real *bonâ-fide* rise. It was easy to make an examination look more serious on paper than it really was. The Committee had not asked for this to be done, but had made representations to the various examining bodies, asking them to raise the standard of the pass-marks rather than increase the difficulty of an examination. Feeling that the Council had the true interests of education at heart, the various examining bodies had met the Committee in the most conciliatory spirit and had, wherever necessary, provided examinations in order to bring about a common good. The Committee expressed the opinion that it would not be practicable to raise the standard of the examinations until the state of secondary education in the country was in a less chaotic condition than it is now. The responsibility lay with the country, and it was sincerely to be hoped that the Government during the next session would bring forward a strong measure by which this important object might be attained. After some discussion, the Council adopted the motion "That the report of the Education Committee on the steps taken for the improvement of preliminary examinations be approved."

SCIENTIFIC SERIAL.

Bulletin of the American Mathematical Society, November.—On wronskians of functions of a real variable, by Prof. Bôcher, has for its object the settling certain questions connected with the subject so as to clear the way for further investigations—such as whether the roots of wronskians of sets of linearly independent solutions can have an infinite number of roots in a given interval, and also the question to what extent the theory of the adjoint (adjungirte) differential equation remains valid when the coefficients of the differential equation are not assumed to be analytic but merely continuous functions. To do this he considers the slightly more general subject of linear families of which the solutions of a homogeneous linear differential equation form a special case. The paper was communicated at the August meeting of the Society, as also was the following, on the configurations of the 27 lines on a cubic surface and the 28 bitangents to a quartic curve, by Prof. L. E. Dickson. After determining four systems of simple groups in an arbitrary domain of rationality which include the four systems of simple continuous groups of Lie, the author was led to consider the analogous problem for the five isolated simple continuous groups of 14, 52, 78, 133 and 248 parameters. The groups of 78 and 133 parameters are related to certain interesting forms of the third and fourth degrees respectively (Cartan's thèses), and these suggest certain forms discussed in the paper.—Dr. G. A. Miller gives an account of the mathematical work done at the fiftieth annual general meeting of the American Association for the Advancement of Science. There are given the titles, with abstracts, of twenty-five papers.—Prof. J. S. Ames reviews "Die partiellen Differentialgleichungen der mathematischen Physik" (nach Riemann's Vorlesungen in vierter Auflage neu bearbeitet von Heinrich Weber, erster bd. 1900, zweiter bd. 1901).—Amongst the notes are included the Cambridge mathematical courses for the current academic year.—New publications as usual.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, November 21.—"On the Properties of the Arterial and Venous Walls." By John A. MacWilliam, M.D., Regius Professor of Physiology in the University of Aberdeen. Communicated by Sir Michael Foster, K.C.B., Sec. R.S.

November 28.—"A Comparative Study of the Spectra, Densities and Melting Points of some Groups of Elements, and of the Relation of Properties to Atomic Mass." By Hugh Ramage, B.A., A.R.C.Sc.I., St. John's College, Cambridge. Communicated by Prof. Liveing, F.R.S.

It has been usual for investigators to rest satisfied when the properties of the elements were shown to be "a periodic function of the atomic mass." Diagrams drawn by the method employed in this paper will show in what degree the properties vary with the atomic mass, and will make it easier to establish the exact quantitative relations.

The work and results presented by the author make it clearer that the properties of the elements are fundamentally due to the structure, as revealed by their spectra, of the atoms rather than to the quantity of matter in them. It is inconceivable, for instance, that the change from calcium to strontium proceeded through the intermediate elements when we consider that the strontium molecules must have a similar structure to those of calcium. This structure is so simple that the fundamental (Bunsen flame) spectrum of each of these elements contains only one line attributed to the element. The anomaly, according to Mendeléeff's law, in the atomic masses of tellurium and iodine is further evidence of this. The properties of these elements may have nothing whatever to do with each other. They are, however, closely related to and in correct order with those of the elements of their respective groups. The genesis was not in the direction of tellurium to iodine, but from, or perhaps through, oxygen and fluorine respectively. So also is this the case with the other groups.

It is more probable that in the genesis of the elements the properties of certain fundamental matter are modified by successive additions of matter to them, or by causes of which this is to us the apparent result. The regularity in the changes in the properties of lithium, beryllium, boron and carbon, as seen in the diagrams, is very remarkable. It is, furthermore, very suggestive, for the changes in properties are approximately proportional to the quantity of matter in the atom in excess of a constant quantity (which is about 6), as if it were the same matter that is added in each case.

Geological Society, November 20.—Mr. J. J. H. Teall, V.P.R.S., president, in the chair.—Dr. Vaughan Cornish exhibited photographs of waves and ripples in water, cloud, sand and snow.—Notes on the Genus Lichas, by Mr. F. R. C. Reed. The Lichadidæ are divided into two great groups: (1) that with a pair of bi-composite lateral lobes to the glabella and a more or less definite fourth pair of lateral lobes; and (2) a group with a pair of tri-composite lateral lobes, through the fusion of the fourth pair with the bi-composite pair of the preceding group. Names are proposed for each group, and also, where necessary, for the eight sections, of subgeneric value, into which each group is subdivided. The

paper closes with a list of the British members of the family Lichadidæ, to show their distribution among the groups and sections.—Some remarks on the meteorological conditions of the Pleistocene epoch, by Dr. Nils Ekholm. The opinion of the author on this subject differs in some important respects from that of Mr. Harmer. He considers the subject under two heads: (1) What are the meteorological conditions necessary and sufficient to produce a permanent ice-sheet such as that of the Great Ice-Age? (2) What will be the influence of such glaciation on the meteorological conditions, especially on the cyclones and anticyclones, of the ice-covered land and on its neighbourhood? The snow-line does not correspond with the mean annual isotherm of 32°, for Verchojansk in Siberia is not glaciated, whereas the southern point of Greenland is. The former has a winter anticyclone, while the latter is traversed by the central or northern part of cyclones during the whole year. The area of Pleistocene glaciation in America and Europe coincides with the areas now traversed by the most regularly frequented storm-tracks. There seems to have been about the same difference between the mean annual temperatures of Europe and North America in the Great Ice-Age as now, and it is generally agreed that a lowering of the present snow-line by 1000 metres would give rise to a similar Ice-Age. The hypothesis that a glaciation of North America would raise the temperature of Europe, and *vice versâ*, seems to the author physically untenable. The positions and movements of anticyclones are not generally ruled by the ground temperature in our latitudes: they are in most cases eddies formed by the air-circulation in general, and in this the greater area and receipt of heat by the equatorial regions must always be a preponderating factor. The author considers that the influence of the Glacial Period on atmospheric circulation would probably be similar to that of a cold winter nowadays. The cyclones would be gradually deviated into a more and more southerly track, while an anticyclone would be formed in the north, not, however, a stationary one, but travelling like a cyclone, only more slowly and irregularly. The summer must have been cold and stormy, with frequent fogs, somewhat like that of Cape Horn or Kerguelen Island at the present day. The author considers that Mr. Harmer underrates the effect of insolation and overrates that of the winds. "The temperature of the summer only is essential for the phenomenon of glaciation."—On the origin of certain concretions in the Lower Coal-Measures, by Mr. H. B. Stocks. In certain of the Lower Coal-Measures of Lancashire and Yorkshire and in the "hard-bed coal," peculiar concretions known as "coal-balls" occur, which have a considerable interest because they contain well-preserved plant-remains. The author's analysis shows that they consist mainly of calcium-carbonate and iron-pyrites, in varying proportions. Carbonate of lime appears to have been introduced by osmosis through the cell-walls; and that it was introduced in small quantity and under exceptional circumstances appears to be proved by the comparative rarity of the concretions and their presence in this seam of coal only. During the decay of the vegetable matter of which coal is formed, in contact probably also with animal matter, some of the organic matter would pass into solution in water, causing the absorption of the oxygen in solution; the result of this is that further decay would take place under anaërobic conditions. This, occurring in water containing sulphates, would give rise to sulphuretted hydrogen and mud blackened by the presence of ferrous sulphide, while carbonates would also be produced. Experiments were tried (1) on the precipitation of carbonate of lime under varying conditions (in presence of organic matter, &c.); (2) on the action of salts of lime and of iron on wood; and (3) on the action of bacteria on solutions containing calcium-sulphate in solution and ferric oxide in the deposit. In the first series carbonate of lime was deposited in spheres; in the second it was found that iron-salts are preservatives but lime-salts are not; and in the third, black mud largely consisting of ferrous sulphide was produced, while the calcium-sulphate was converted into carbonate. It is considered that these experiments explain the origin of the "coal-balls."

Linnean Society, November 21.—Prof. S. H. Vines, F.R.S., president, in the chair.—Dr. A. B. Rendle showed specimens of *Rubus australis*, Forster, the New Zealand "lawyer-vine," which had been sent by Mr. F. W. Burbidge from the Trinity College Botanic Gardens, Dublin. The specimens, which comprised three forms, furnished a striking example of variability within the range of a single species. One, the leafy form, bore leaves with three large leaflets somewhat prickly on the stalks and midrib, recalling our native blackberry. In an intermediate form the leaflets were much reduced in size, while the stalks were longer and much more prickly. In a third the flat leaf-surface had completely disappeared, the leaves now consisting of an elongated stalk bearing long naked midribs, beset, like the leaf-stalks and the stem, with strong, short, recurving prickles, by means of which the plant climbs over surrounding vegetation. Mr. Burbidge states that the three forms are from three distinct plants, reared from seeds sent from New Zealand; they are said to be permanent under cultivation.—The president gave some account of his investigation of the proteolytic enzyme of Nepenthes. He began by pointing out that in the higher animals there are two distinct proteolytic enzymes: (1) pepsin, secreted by the stomach; (2) trypsin, secreted by the pancreas. The action of pepsin upon the more complex proteids (albumin, fibrin, &c.) is to convert them by hydrolysis into simpler proteids known as peptones; whereas the action of trypsin is not only to convert these proteids into peptones, but, further, to decompose the peptones into non-proteid nitrogenous substances, such as leucin, tyrosin, &c. Among these final products of tryptic digestion there is a substance termed tryptophan, which has the property of giving a pink or violet colour on the addition of chlorine-water. Hence this colour-reaction may be used as a means of determining the nature of the digestion to which any proteid may have been submitted. As the result of previous researches upon the nature of the digestion effected by the enzyme of Nepenthes, the president had come to the conclusion that it was not peptic, as had been supposed, but essentially tryptic. This conclusion has recently been called in question by Clautriau (Acad. Roy. de Belgique, 1900), who reasserts the peptic character of the enzyme. By means of the tryptophan-reaction, which is readily given by the products of a Nepenthes digestion, the president has been able to establish the correctness of the view that the enzyme is tryptic. The tryptophan-reaction has also been found to be given by a number of extracts of plants which are known to contain a proteolytic enzyme; for instance, pineapple-juice, papaïn, figs, germinating bean-seeds, &c. It seems probable, therefore, that proteolytic digestion in plants is always tryptic—that there is, in fact, no peptic enzyme in plants. But there is this peculiarity about the trypsin of plants, that it has to work in an acid medium.—A paper by Mr. T. F. Cheeseman on the flora of Rarotonga was read on his behalf by Dr. O. Stapf, who also showed some of the more interesting plants collected on the island.

Entomological Society, November 20.—Mr. G. H. Verrall, vice-president, in the chair.—Mr. A. H. Jones exhibited various Lepidoptera from the Cevennes, including a series of *Lycaena dolus*, var. *vittata*, *L. damon*, *L. meleager*, *Melanargia iapygia*, var. *cleanthe*, and *M. galatea ab. leucomelas*: also a dark form of *Thais cerisyi* bred from a pupa received from Armenia. He also exhibited a specimen of *Vanessa antiopa* taken this year at Eltham, and two specimens of *Cerastes erythrocephala* bred from ova laid by parent moth captured at sallows near Canterbury.—Mr. H. Rowland-Brown exhibited a remarkable var. of *Melitaea didyma*, taken at Chateau de la Câze, Tarn, in which the black markings of the under wings were almost entirely absent, and a series of *Lycaena dolus*, var. *vittata*, from the Cevennes, with *L. admetus*, var. *rippertii*, from Digne, showing the remarkable affinity of the two species, which, however, were never found on the same ground or in the same localities while collecting.—Dr. Chapman exhibited butterflies taken by himself and Mr. G. C. Champion in the Sierra Albarracin, Spain, last July, practically the same district as that traversed and described by Mrs. Nicholl in her paper in the Society's Transactions for 1897, and not many new butterflies were added to Mrs. Nicholl's list. *Z. quercus* was taken at Tragacete. *Augiades sylvanus* was taken both at Albarracin and Tragacete. *Adopaea actaeon* was met with a Cuenca (Castile), while *Adopaea linea* seemed to be more abundant than *A. lineola* at all stations. *L. hylas* and its variety *nivescens* were found on the same ground. The common form of *L. corydon* seemed to be *corydonius* or near that variety, while the very large pale form *hispana* was the commonest at Albarracin, where the *corydonius* form was rare.—Mr. L. B. Prout exhibited and commented upon a number of Geometridæ also taken by Dr. Chapman and Mr. Champion in Spain.—Mr. F. Merrifield exhibited specimens of *Pieris rapae* and *Pieris ergane* from

Dalmatia, showing that the two species are extremely difficult to separate, even if they are not identical.—Mr. C. P. Pickett exhibited varieties of *Argynnis paphia* and *A. aglaia* from the New Forest.—Mr. C. J. Watkins sent for exhibition microphotographs of the larva in its case and the perfect insect of an *Oxyethira*, one of the *Hydroptilidae*, a family of *Micro-Trichoptera;* these had been taken by Mr. Mearns, of Aberdeen. Also a drawing made by himself under the microscope of a larva (in its case) of the same genus.

Royal Microscopical Society, November 20.—Mr. Wm. Carruthers, F.R.S., president, in the chair.—Four microscopes of great interest were presented to the Society. Descriptions of three of these prepared by Mr. Nelson were read. With regard to one made by Powell and Lealand in 1848, Mr. Nelson writes:—This form was the first instance in which the microscope was hung in a tripod, and it was also the first where the fine adjustment moved a nose-piece by means of a lever inside a bar movement, and this specimen must have been about the last microscope made with the fine-adjustment screw at the side of the bar, for it was in this year, 1848, that the screw was placed vertically above the lever, where it has remained ever since. Other features were referred to, and Mr. Nelson characterised it as historically an important and not very common form of Powell and Lealand's microscope. The next microscope described was an old one made by Hugh Powell, certainly before 1841, as in that year Mr. Lealand joined the firm, and his name would have been coupled with that of Powell, and the presence of a substage condenser prevents it being dated earlier than 1839. An important feature is the stage, which has an arrangement for focussing by means of three wedges, moved by a micrometer screw. The stage has also a transverse micrometer movement for the measurement of objects. The third microscope was made by John Cuff. The date of its introduction was 1744 and it was called "A New Constructed Double Microscope." After the John Marshall microscope this is historically one of the most important instruments in the Society's collection. The other microscope presented was made by Plössl and Cie, Vienna, and has already been described in the *Journal* of the Society.—Messrs. R. and J. Beck exhibited a new pattern microscope embodying several new features. The substage was fitted with coarse and fine adjustments and means of throwing out the condenser while it was in focus. The stage, 5 inches diameter, was rotating and graduated on the periphery, with a removable mechanical stage graduated as a finder. The body was very short, fitted with double draw tube, which allowed the body to be extended to 11½ inches. The body was fitted with Ashe's new double fine adjustment.—Mr. Conrad Beck gave an exhibition of antipoints, and said they were extremely difficult to show on account of the trouble there was in obtaining points of light sufficiently small and bright, and it was only possible to obtain faint images with so much diffused light as there was in that room. There were six microscopes, all having ½-inch objectives, and the points of light in the first two cases were produced by minute apertures in tinfoil, in the others the light was reflected from small mercury globules. With the first microscope a point of light was viewed with ½-inch objective of ordinary aperture and showed a *point* of light surrounded with faint diffraction circles. With the second microscope a similar point of light was viewed with a ½-inch objective of very small aperture and showed a *disc* of light and diffraction rings. The other microscopes showed the effects produced by placing various stops behind the objectives, and also by viewing the point of light through a grating which extended the whole aperture of the objective. Mr. J. W. Gordon said he had listened with great interest to Mr. Beck's explanation of the demonstration and was anxious to see the examples, and no doubt the experiments would demonstrate the existence and appearance of the antipoint in each case; but there was another and equally important image which he would like to see and that was the antipoint which was formed in the eye, and he hoped some day Mr. Beck would be able to give a demonstration of this.—A paper on stereomicrography, by Prof. G. P. Girdwood, of M'Gill College, Montreal, was read by the secretary. Prof. Girdwood's method of obtaining stereo-microphotographs was by placing the slide or object in a tilting frame attached to the stage of the microscope. The frame with the object was tilted to one side to the proper angle and a photograph was taken; the frame was then tilted to an equal amount in the opposite direction and another photograph was taken. Prints from the negatives were then mounted in the usual way to form stereoscopic pictures. The paper was illustrated by a diagram on the blackboard, and a specimen of the stereoscopic photographs, placed in a stereoscope, was passed round the room.

DUBLIN.

Royal Dublin Society, November 20.—Prof. W. Noel Hartley, F.R.S., in the chair.—Prof. T. Johnson gave an account of the results of field experiments he had conducted during the past two years in the west and north-west of Ireland in the prevention of "smut" (*Ustilago avenae*, Jens.) in oats. The fungicides used were potassium sulphide (weak and strong solution), copper sulphate, formalin alone, and followed by ammonia, and the new fungicide "sar" (essentially sodium sulphide) recommended by the United States Department of Agriculture. The latter was found by the author to be the most efficient remedy.—Dr. F. T. Trouton, F.R.S., described some experiments made by him at the request of the late Prof. G. F. FitzGerald, in which it was sought to detect an effect depending on the relative motion of the earth and ether. A charged condenser placed with its plates edgeways to its motion through the ether should possess a magnetic field. The question to be investigated was the source of the energy for this field. FitzGerald's supposition was that at the moment of charging the condenser should experience an impulse in the direction opposed to its motion and on discharging in the direction of motion. A condenser was therefore delicately suspended at the end of a cross-arm with a balance weight at the other end held by a torsion wire. The arm stood north and south and it was sought to detect at 12 o'clock if there was an impulse acting on the condenser when it was charged and discharged. This was effected synchronously with the period of the apparatus by a clock. No effect was observed though the calculated effect was long within the range of delicacy. FitzGerald had anticipated the possibility of a negative result being obtained through the same cause as was suggested by him and Lorenz to account for the negative results obtained by Michelson and Morley in their interference experiments, namely, the alteration in the weight of matter with direction of motion through the ether. The alteration thereby produced in the electrostatic energy would in this way provide the necessary energy for the magnetic field. The author pointed out that if it be thought that the energy from the magnetic field is attributable to the charging battery, it follows that charge condensers tend to set themselves at right-angles to the earth's motion through space. For on this hypothesis a condenser charged in the latter position and rotated must have work done on it to energise the magnetic field thereby produced. Thus, in this case it would be a couple that should be looked for and not a directed impulse. He proposed to test this by delicately suspending a light condenser charged to a high voltage. It was also pointed out that if this were true it would be possible to obtain continuous rotation thereby, and thus to construct a machine to utilise the vast stores of energy in the earth's motion through space.—Prof. W. N. Hartley read a paper on haze, dry fog and hail. Last February a paper by the author, conjointly with Mr. Hugh Ramage, was communicated to the Royal Society, on the mineral constituents of dust and soot from various sources. Solid particles brought down by rain, hail, snow and sleet were submitted to analysis by means of the spectrograph, an instrument by which the composition of very minute quantities of substances is ascertained by photographing their spectra. For comparison with these different kinds of dust, and to ascertain their origin, the spectra of various other kinds of matter were photographed, for instance, meteorites, volcanic dust, soot, and flue dust from different chemical works and iron smelting furnaces. The result of this examination showed that the origin of the dust could in certain cases be ascertained from its composition. In the present paper the author described the discharge of vast volumes of dust and fume at very high temperatures into the upper atmosphere which he had observed in furnace operations at various metallurgical works in England and Wales. He had arrived at the conclusion that such material as had fallen in Ireland was the product of the industrial centres of South Wales or South Staffordshire and possibly the pottery district of North Staffordshire. In certain cases it may have come from the centre of the alkali manufactures about Widnes in Lancashire and Runcorn in Cheshire. There is also a likelihood that the neighbourhood of Glasgow contributes a good deal, as, for instance, on the occasion in 1898, when with a slight north-easterly wind black rain fell in Ireland over an area of 500 square miles.

EDINBURGH.

Royal Society, November 18.—Lord M'Laren in the chair.—In a paper on the equilibrium of stellar atmospheres, Dr. Halm applied the principles of thermodynamics to the problem of the convective equilibrium of masses of gas such as constitute the atmospheres of celestial bodies. A theoretic formula was established from which, under given conditions of boundary temperatures, the minimum temperature consistent with convective equilibrium could be calculated. In the case of our own atmosphere, it appeared that thermostatic equilibrium could exist when the temperature was lower than 45° or 50° F.; but that at higher temperatures the equilibrium must be convective. In the case of the sun, however, it was found that even with very extreme assumptions as to the temperature of the uppermost layers of the atmosphere there could be a layer of only inappreciable thickness in which thermostatic equilibrium was maintained. The equilibrium was practically convective throughout the whole mass, a result in full accordance with the facts of observation. The theory also gave a formula for calculating the height of a stellar atmosphere. When applied to the case of the sun the height of the hydrogen atmosphere came out much smaller than the observed height—a discrepancy which may be removed by the assumption that there is dissociation going on, so that the specific heat of hydrogen greatly increases at the higher temperatures. A full discussion of these and related results was held over for a subsequent paper.—Dr. Peddie read a paper on quaternion binaries, an extension of quaternions giving an eight-element system applicable to ordinary space. In this system vectors are regarded as translators only. A special operator R transforms them into rotors, and a second application of the same operator transforms the rotor into a translator. The system is formally Hamilton's, with the removal of the restriction that vectors shall act as translators in addition and as rotors in multiplication. The quantities ijk being unit rectangular vectors, the fundamental equations may be written

$$\mathrm{R}ij = k,\ \mathrm{R}jk = i,\ \mathrm{R}ki = j,$$
$$i^2 = j^2 = k^2 = -1,\ \mathrm{R}^2 = +1.$$

The fundamental properties of the quaternion binary $\mathrm{B} = q + \mathrm{R}r$, where q and r are quaternions, were investigated, the applications being restricted to the theory of screws, in particular to screws upon a cylindroid.—Prof. Chrystal, in a further note on Miller's trisectrix, pointed out its relation to the quartic trisectrix, and exhibited a seven-bar linkage for tracing all varieties of limacon. It was built up of a rhombus guided in its motions by two contraparallelograms.

PARIS.

Academy of Sciences, December 2.—M. Fouqué in the chair.—On the essential singularities of differential equations, by M. Paul Painlévé.—Observations of Leonids made at Athens, by M. D. Eginitis. On the nights of November 14, 15 and 16 the conditions were favourable for observations, and in all some 147 meteors were seen. They were generally red and brilliant, and appeared to radiate from two distinct points separated by some degrees.—On the deformation of surfaces and of quadrics in particular, by M. L. Raffy.—On the number of roots common to several equations, by M. G. Tzitzeica.—On an application of the prism of Govi to the realisation of an apparatus for verifying rules, by M. A. Lafay.—A method allowing of the evaluation in absolute measure of very low temperatures, by M. Henri Pellat. It has been known for some time from the researches of Lord Kelvin that the rate of change of the electromotive force of a thermocouple with the temperature is equal to the ratio of the coefficient of the Peltier effect to the absolute temperature. A method is sketched out by the author in which this relation is applied to the practical calibration of a thermocouple in absolute temperatures. It is estimated that the method would permit of an accuracy of 0°·5 in the neighbourhood of 150° C. absolute, and of from 1° to 1°·5 at 75° and 20° absolute.—The application of the Lagrangian equations to electrodynamical phenomena, by M. E. Carvallo.—On the disruptive discharge in electrolytes, by M. H. Bagard. Methods are described by which the results obtained by MM. Broca and Turchini in the case of disruptive discharge of electrolytes that are good conductors can be reproduced in a much simpler manner.—On the spark of the Hertz exciter, by M. C. Tissot. A photographic study of the sparks given by a transmitter used in wireless telegraphy shows that the images of successive sparks are not rigorously equidistant, the first being always longer than the others. This appears to be connected with the fact observed by M. Hemsalech, that the spectrum of the first discharge contains only air lines, whilst the rays of the metal appear in the others.—On the induced radio-activity produced by radium salts, by MM. P. Curie and A. Debierne.—The influence of radio-active substances on the luminescence of gases, by M. Alix de Hemptinne. It has been found that if a radio-active substance is brought near a tube containing air at low pressure and submitted to electrical vibrations, it becomes luminous at a higher pressure than is the case if the radio-active substance is not present, the light, which was of a violet-red colour in the latter case, being a greenish-yellow under the action of the radium.—Contribution to the study of the tin-aluminium alloys, by M. Leon Guillet. Two well-defined alloys of tin and aluminium have been isolated in the form of crystals, corresponding to the formulæ $AlSn$ and Al_4Sn.—The action of pyridine bases on the tetra-halogen derivatives of quinones, by M. Henri Imbert.—On *Dorstenia klaïneana*, and on the chemical composition of its root compared with that of *Dorstenia brasiliensis*, by MM. Heckel and F. Schlagdenhauffen.—The composition of the reserve carbohydrates in the albumen of the seeds of some Liliaceæ and in particular of the butcher's broom, by M. Georges Dubat. The hydrolysis of the seeds gives about 70 per cent. of reducing sugars, of which about one-fifth is invert sugar, two-fifths glucose, and two-fifths mannose.—On the constitution of wheat, by M. E. Fleurent.—On the modifications which the hæmoglobin of the blood undergoes under the influence of a reduction in the atmospheric pressure, by M. J. Vallot. From experiments carried out on Mont Blanc it was found that the rarefaction of the air produces immediately in man an increase in the activity of the exchanges, tending to compensate the deficiency of oxygen. Fatigue tends to oppose this increase, and may so far overbalance it as to produce mountain sickness. But this effect disappears after prolonged rest at a high altitude, and the increase in the activity of the exchanges goes on for some time until the body becomes acclimatised. On descending, the return to the normal rate of exchange is prolonged in proportion to the length of sojourn above.—The physical and chemical phenomena of respiration at different altitudes during a balloon ascent, by MM. J. Tissot and Hallion.—New researches on the dissociation of carbonoxyhæmoglobin, by M. N. Gréhant. The destruction of carbonoxyhæmoglobin existing in the blood is much more rapid when pure oxygen is breathed than when air is breathed; in the latter case the amount of carbon monoxide in the blood remains constant for nearly twenty minutes after the breathing is commenced.—Researches on the effect of the stings of *Latrodectus* 13-*guttatus*, by M. L. Bordas. In Corsica and other countries the effect of these stings is considered very dangerous, but it is shown in the present series of experiments that such stings are never mortal in man or the larger animals, although proving rapidly fatal to certain insects, coleoptera and orthoptera.—The influence of diseases of the parents upon the imperfections of the offspring. Tuberculous lesions without microbes, by MM. A. Charrin and Gabriel Delamere.—On two diseases of the leaves of chrysanthemums not previously described, by M. H. Joffrin.—On the existence of a principle, toxic to the pear tree, in the berries, seeds and stems of mistletoe, by M. Émile Laurent.—The phenomena of the capture of superficial water courses by subterranean streams in calcareous districts, by M. E. Fournier.—On the three crystophyllian series of the western Alps, by M. Pierre Termier.—Experimental complement to the history of the striated gravels, by M. Stanislas Meunier.

NEW SOUTH WALES.

Royal Society, October 2.—Mr. H. C. Russell, C.M.G., F.R.S., president, in the chair.—On the relation between leaf venation and the presence of certain chemical constituents in the oils of the Eucalypts, by Mr. R. T. Baker and Mr. Henry G. Smith. In this paper the authors show that there exists a marked agreement between the venation of Eucalypts leaves and the characteristic constituents in their oils. The venation shown by the leaves of the "bloodwoods" *E. corymbosa*, *E. trachyphloia*, &c., is indicative of a predominance of pinene in the oils and an absence of phellandrene. It is this end of the Eucalyptus series that is more closely associated with the Angophoras, because the venation of the leaves is similar and the chemical constituents in agreement.

As the series descends through such species as *E. botryoides*, *E. saligna*, &c., we reach those Eucalypts of which the principal oil constituents are pinene and eucalyptol, the latter constituent increasing in amount until such excellent eucalyptol oils as those of *E. globulus*, *E. Smithii*, *E. longifolia*, &c., are reached. The venation of the leaves of these species is similar, is more open, the individual lateral veins having become more distinct, and with the bending of the marginal vein, commencing to form the looping so characteristic of the phellandrene-peppermint group, the species of which include those of *E. dives*, *E. radiata*, *E. amygdalina*, *E. Sieberiana*, &c. The principal constituent in these oils is phellandrene, and at the extreme end this constituent is present in such abundance as to exclude, almost entirely, the eucalyptol. The pinene which was such a prominent constituent in the oils of the earlier members of the series is only present in the oils of this group in minute quantities. The looping appearance of the venation of the members of the phellandrene-peppermint group has become more open, and the spaces between the principal lateral veins are larger. With the subordination of many of the original lateral veins the spaces provided for the formation of the oil glands is larger, and consequently we find these more numerous in the members of this group; the yield of oil obtainable is therefore much greater, and it is this feature which enables such enormous yields of oil to be obtained from such species as *E. amygdalina*, *E. dives* and *E. radiata*.

DIARY OF SOCIETIES.

THURSDAY, DECEMBER 12.

ROYAL SOCIETY, at 4.30.—On the Action of the Spurge (*Euphorbia hiberna*, L.) on Salmonoid Fishes: Dr. H. M. Kyle.—Contributions to the Chemistry of Chlorophyll. No. VIII. Changes undergone by Chlorophyll in passing through the Bodies of Animals: Dr. E. Schunck, F.R.S.—The Result of Chilling Copper-Tin Alloys. Second Communication. C. T. Heycock, F.R.S., and F. H. Neville, F.R.S.—The Effective Temperature of the Sun: W. E. Wilson, F.R.S.

MATHEMATICAL SOCIETY, at 5.30.—Flexure of a Circular Plate: J. H. Michell.—Non-uniform Convergence, and the Integration of Series: Dr. Hobson, F.R.S.

INSTITUTION OF ELECTRICAL ENGINEERS, at 8.—The Physical Properties of certain Aluminium Alloys and some Notes on Aluminium Conductors: Prof. E. Wilson (conclusion of discussion).—Some Principles underlying the Profitable Sale of Electricity: Arthur Wright.

CHEMICAL SOCIETY, at 8.—Extraordinary General Meeting.

FRIDAY DECEMBER 13.

PHYSICAL SOCIETY, at 5.—On Circular Filaments and Circular Magnetic Shells equivalent to Circular Coils, and on the Equivalent Radius of a Coil: Prof. Thomas R. Lyle.—Air Pressures used in playing Brass Instruments: Dr. Barton and S. C. Laws.—A New Hygrometric Method: E. B. H. Wade.

ROYAL ASTRONOMICAL SOCIETY, at 5.—The Observed Motion and Duration of the Radiant Point of the Leonids: W. F. Denning.—Observations of Nova Persei: J. E. Gore.—Apparent Paucity of the Leonid Stream: Rev. S. J. Johnson.—Contribution to the History of the Reflex Zenith Tube: S. C. Chandler.—*Probable Papers*: On the Accuracy of Measures on Photographs: Remarks on Recent Papers by M. Lœwy and Mr. H. C. Plummer: A. R. Hinks.—Description of Adams's MSS. on the Perturbations of Uranus: R. A. Sampson.

MALACOLOGICAL SOCIETY, at 8.—On the Anatomy and Relationships of *Voluta musica*, Linn.; with Notes upon other supposed Members of the *Volutidae*: S. Pace.—Descriptions of a New East African *Ennea* and a N.W. Australian *Thersites* (*Rhagada*): H. Fulton.—*Eulota blakeana*, Newc., and *E. luna*, Pils.: G. K. Gude.—Note on the Pairing of *Pyramidula rotundata* with *Vitrea lucida*: Mons. Caziot.

EPIDEMIOLOGICAL SOCIETY, at 8.30.—Dysentery in Asylums: Dr. Mott, F.R.S.

SATURDAY, DECEMBER 14.

ESSEX FIELD CLUB (at Essex Museum of Natural History, Stratford), at 6.30.—Contributions to the Pleistocene Geology of the Thames Valley. I. The Grays Thurrock Area, Part II.: A. C. Hinton and A. S. Kennard.—The Water-Mites (Hydrachnidæ) of Epping Forest: C. D. Soar.—Manganiferous Nodules in the Boulder-clay Soils of Essex: Miss Thresh.

MONDAY, DECEMBER 16.

SOCIETY OF ARTS, at 8.—The Chemistry of Confectioners' Materials and Processes: William Jago.

IMPERIAL INSTITUTE, at 8.30.—The Economic Resources of the Straits Settlements and the Malay Peninsula: H. N. Ridley.

TUESDAY, DECEMBER 17.

ZOOLOGICAL SOCIETY, at 8.30.—On the Structure of the Larval *Polypterus*: J. S. Budgett.—On the Spawn and Young of a Polychæte Worm of the Genus *Marphysa*: L. A. Borradaile.—On the Anatomy of Gruiform Birds, with Special Reference to the Correlation of Modifications: Dr. P. Chalmers Mitchell.

INSTITUTION OF CIVIL ENGINEERS, at 8.—Motive Power from Blast-furnace Gases: Bryan Donkin.

ROYAL STATISTICAL SOCIETY, at 5.—The Suspension of the Berlin Produce Exchange, and its Effect on Corn Prices: R. H. Hooker.

WEDNESDAY, DECEMBER 18.

SOCIETY OF ARTS, at 8.—Range Finders: Prof. George Forbes, F.R.S.

GEOLOGICAL SOCIETY, at 8.—Coal- and Petroleum-Deposits in European Turkey: Lieut.-Colonel Thomas English.—(1) On the Geological and Physical Development of Dominica, with Notes on Martinique, St. Lucia, St. Vincent and the Grenadines; (2) On the Geological and Physical Development of Barbados, with Notes on Trinidad: Prof. J. W. Spencer.

ROYAL METEOROLOGICAL SOCIETY, at 7.30.—Further Observations and Conclusions in relation to Atmospheric Transparency: Hon. F. A. Rollo Russell.—Remarkable Phosphorescent Phenomenon observed in the Persian Gulf, April 4 and 9, 1901: W. S. Hoseason.—On the Mechanical Principle of Atmospheric Circulation: Captain R. A. Edwin, R.N.

ROYAL MICROSCOPICAL SOCIETY, at 8.—Development and Structure of Eyes, illustrated by Micro-slides: F. W. Watson Baker.

THURSDAY, DECEMBER 19.

LINNEAN SOCIETY, at 8.—On the Brain of Recent and Fossil Lemurs: Dr. G. Elliot Smith.—On the Ostracoda collected round the Funafuti: F. Chapman.—Exhibitions: A Gigantic Argulus from Japan and a Specimen dredged at the Cape: Prof. G. B. Howes, F.R.S.—A New Polyzoon from Tanganyika: J. E. S. Moore.—An Example of White's Thrush (*Turdus varius*), shot near Clavering, Essex: Miller Christy.

CHEMICAL SOCIETY, at 8.—(1) Corydaline. Part VII. The Constitution of Corydaline; (2) The Relation of Corydaline to Berberine. The Oxidation of Berberine with Nitric Acid: J. J. Dobbie and A. Lauder.—The Magnetic Rotation of some Polyhydric Alcohols, Hexoses, and Disaccharoses: W. H. Perkin, F.R.S.—Stereoisomeric Halogen Derivatives of α-benzoylcamphor: H. O. Forster and F. M. G. Micklethwait.—Is Argon an Elementary Substance? G. Martin.

INSTITUTION OF ELECTRICAL ENGINEERS, at 8.

FRIDAY, DECEMBER 20.

INSTITUTION OF CIVIL ENGINEERS, at 8.—Transmission Dynamometers: A. M. Morgan.

INSTITUTION OF MECHANICAL ENGINEERS, at 8.—The Microscopical Examination of the Alloys of Copper and Tin: W. Campbell.

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THURSDAY, DECEMBER 19, 1901.

THE FACE OF THE EARTH.

Das Antlitz der Erde. Von Eduard Suess. Mit 23 Textabbildungen, 6 Tafeln und einer Karte der Scheitel Eurasien's. Dritter Band. Erste Hälfte. Pp. iv + 508. (Wien: Tempsky, 1901.) Price 25*s.* net.

La Face de la Terre. Par Eduard Suess. Traduit avec autorisation de l'Auteur et Annoté sous la Direction de Emmanuel de Margérie. Tome II. Pp. 878. (Paris: Colin, 1900.)

SINCE the publication of Lyell's "Principles" no general treatise on geology has aroused more interest or exercised a more important influence on the evolution of geological ideas than "Das Antlitz der Erde," the first two volumes of which were reviewed in NATURE of April 25, 1889. Thirteen years have elapsed since the second volume appeared. It left the plot—if we may be allowed to use that expression—in a somewhat complicated condition, but the interest was maintained and not a little curiosity was aroused as to how the distinguished author would weave the various threads together. The first part of the last volume is now before us, but the mystery is not solved. We must wait with such patience as we can command until the conclusion appears.

As the leading ideas which run through the entire work may not be familiar to all readers of NATURE, a brief account of them will be given before proceeding to the review of the new volume. It must, however, be remembered that the work contains a careful and elaborate statement of facts relating to the structure of almost every part of the world, and is, therefore, of great value as a work of reference, quite apart from the truth or error of the theoretical views of the author.

A study of the structure of the earth's crust proves that it has been affected by two types of movement—the one characterised by a compression of the stratified rocks along certain zones, the other by a separation of the crust into blocks, some of which have sunk down relatively to others. The first type is best illustrated in modern mountain ranges, such as the Alps and Himalayas, the second in districts which have not recently been affected by folding movements.

One and the same area cannot be simultaneously affected by these two types of movement, but a folded zone may, after the folding stresses have ceased to act, be broken up by more or less vertical faults and by the sinking down of certain portions. It is probable that no part of the earth's surface has escaped the action of lateral pressure, but large tracts—as, for example, the north of Russia—have not been affected by it since pre-Cambrian times.

By the sinking of certain areas ocean basins are formed, enlarged or deepened, and terrestrial features like the Great Rift Valley of Central Africa are produced. When the sinking process takes place those parts of the crust which remain stationary, or which do not sink so much as the others, are termed "horsts." According to the author, the continents are of the nature of "horsts"; they have not been formed by elevation, but by the sinking of the intervening tracts.

In support of such a view he refers especially to the fact that no proofs of the presence of a Mesozoic sea are to be found over southern India or the corresponding portion of Africa. On the contrary, the continental deposits of the Gondwana and Karoo series end off abruptly against the ocean. Such facts as these are, he considers, incompatible with the view that continents have been formed by elevation.

But although the existing oceans have been formed by depressions, it must not be supposed that all parts of any one ocean are of the same age, any more than that the continents have been formed by one simple or continuous process. The modern Atlantic, for example, has probably been produced by an enlargement in a northern and southern direction of Neumayr's Centrale Mittelmeer.

The geologist, however, has not only to deal with movements of the earth's crust, but also with changes in the relative level of land and sea. In speaking of such movements Prof. Suess considers that we should adopt a phraseology independent of theory. A rise of sea-level he terms a positive movement and a sinking of the sea-level a negative movement. The Black Sea and the Ægean Sea are both of quite recent date. If no water occupied these areas before the sinking took place, a lowering of the sea-level all the world over to the extent of about four metres must have been produced when they were formed. The crust of the earth breaks in and the sea follows; but whilst the depressions of the lithosphere are limited in extent the lowering of the sea-level is universal.

If we study the succession and distribution of sedimentary deposits we find, over large areas, clear evidence of transgressions or, in other words, of positive movements; these must have been of great extent and duration. Comparative stratigraphy shows that the positive and negative movements are too widely extended to be due to local movements of elevation and depression affecting the solid crust. Thus the Upper Cretaceous transgression, which forms such a striking feature in the geology of southern England, makes itself felt on the Amazon, on the Athabaska and on the Elbe, on the banks of the Nile and in the Tarim Basin, in the valley of the Narbudda and in Borneo, in the island of Sachalin and on the banks of the Sacramento.

The very fact that we are able to employ the same terminology to distinguish the broader sedimentary groups in all parts of the world is a proof that the limits of these groups have been determined by general and not by local causes. England is peculiarly well adapted to furnish the basis for a general classification, because the more important negative movements are here clearly marked out by the intercalation, in the marine series, of continental or fresh-water formations; and the limits established by William Smith and his successors correspond, for the most part, to these movements. At the commencement of a negative phase portions of the oceanic areas become isolated, saline and gypsiferous deposits are formed and the marine fauna becomes impoverished, but its final disappearance only takes place after the negative phase has reached its maximum.

It must not be supposed that the movements are continuous. Just as the actual limit of the water is continually oscillating backwards and forwards during the rise and fall of the tide, so it is with the positive and negative

movements which are recorded in the rocks; the positive movements appear to last much longer than the negative movements which follow them. From the Rhætic to the Callovian in Europe there was an encroachment of the sea upon the land subject only to minor regressions, but the succeeding negative phase which is marked by the Portlandian and Purbeckian was of comparatively short duration.

How are these slow positive movements to be accounted for? The deposition of sediment necessarily tends to produce a continual rise of the sea-level. The formation of the Black Sea and the Ægean Sea, as we have pointed out, would account for a general lowering of the sea-level to the extent of 4 metres; but to produce a corresponding movement in the opposite direction by denudation and deposition would require the transference of an amount of solid rock equivalent to the lowering of the general surface of the land by as much as 10 metres.

The author, however, hesitates to draw the conclusion that the principal positive movements are the result of this cause, and favours the idea that, in some unknown manner, the waters of the ocean have been alternately heaped up at the equator and the poles.

We turn now to the volume which forms the more immediate subject of this review. It deals mainly with those portions of Asia on which so much light has been thrown during the last decade by the indefatigable researches of Russian geologists; the method of treatment is that with which all readers of the first two volumes are familiar. Broad generalisations are suggested in a few words, and then follows a mass of local detail which it is impossible to understand fully without better maps than those which illustrate the work or which are to be found in any ordinary atlas. We look forward with interest to the publication of the French translation, for in the matter of maps and illustrations the French editions of the first two volumes are superior to the original German work. We owe a deep debt of gratitude to M. Margérie and the other distinguished French geologists who have taken so much pains in the translation of this remarkable work and in the selection of additional maps and illustrations.

Different observers have taken different views as to the structure of Asia, but all are agreed as to the existence of a certain uniformity of plan. Prof. Suess calls attention to the predominance of bow-like forms. Such forms are seen on the shores of the Pacific and in the festoon-like arrangement of the adjacent islands, on the Ganges, the Indus and in Iran. The bows may be strongly or weakly bent, crowded together or separated from each other, but they are always arranged in such a way as to suggest a relation to some central nucleus. This nucleus the author finds in the neighbourhood of Irkutsk and Lake Baikal. It is a region of Archæan gneisses and schists which has been broken up into "horsts" and "sinkings." The great amphitheatre of Irkutsk which is drained by the Angara forms a notch in "the old nucleus" (der alte Scheitel). It has been formed by sinking and is bordered by powerful faults.

As the nucleus is approached, the forms of the mountains change. In the neighbourhood of the sea volcanoes occur; further inwards the snow-clad peaks of the giant mountains form the dominant features; to these succeed the rock-walls of the Gobi, which rise above the lower ground formed of horizontally stratified deposits. From the Altai to the region south of Lake Baikal and onward to the Upper Amur, the features are characteristic of an old mountain land which has been more or less completely worn down by denudation. The mountains here have rounded summits, and rest on broad bases. The river systems are fully developed, and when rapids occur they can be traced to comparatively recent changes, such as the outpouring of basalt. These are the characteristic features of the old nucleus. To the north of this nucleus the elevations are tabular and are often formed of flat-lying Palæozoic strata capped by later basalts. In the tundra region of the extreme north, marine horizontal strata give evidence of the Mesozoic transgression.

So far we have been referring only to the introduction. The second section deals with Siberia, which is divided into two well-marked areas, the west Siberian plain and the east Siberian tableland. The only eminences which rise above the alluvial flats in the western plain, between the Yenesei and the Obi, are relics of a once extensive sheet of soft Tertiary sandstone. The Middle Jurassic transgression, which is traceable from the Arctic regions over the Petchora to Cracow, extends from Russia through the low grounds of Turan to Baluchistan and round the shores of the Indian Ocean, but has not as yet been recognised in western Siberia. The only traces of the widespread Upper Cretaceous transgression occur in western Siberia at Ajat, in the south-west corner. Marine deposits with characteristic European fossils here lie on folded Palæozoic strata.

The Tertiary seas (Upper Eocene and Lower Oligocene) gained access to Siberia through the Straits of Turgai (south of the Urals), and reached as far as Semipalatinsk and Sosswa. About the middle or end of the Oligocene period, all connection with the European seas was cut off and the flora of the amber forests spread over the regions vacated by the sea. This great negative movement led to the isolation of oceanic areas both in Europe and Asia, and to the formation of extensive salt-deposits.

The east Siberian tableland is bounded on the south by the old nucleus, on the north-east by the bow of the Werchogan Mountains, on the north-west by the mountains of the Taimyr Peninsula and on the north by the frozen sea. The Lena belongs to the tableland, and flows in a valley which is often 300 metres deep. Four elements take part in the structure of this plateau region. The first is the Palæozoic floor, which probably underlies the whole. The lowest beds belong to the *Olenellus* zone. They are horizontal except on the borders of the amphitheatre of Irkutsk. This amphitheatre has already been referred to as a sunken portion of the old nucleus which is bordered by powerful faults. Folding and even overfolding are associated with these faults, and the direction of overfolding, as so frequently happens under similar circumstances, is directed towards the centre of the sunken tract.

The second element consists of plant-bearing beds, which often contain workable coal. *Asplenium whitbyense* is common, and the deposits were referred by Heer to the Middle Jura. The rocks are sandstone and conglomerate. Plant-bearing beds of the same general type

are widely distributed in Central Asia, and it is practically certain that they are not all of the same age; thus Zeiller has recognised affinities with the Gondwana flora and has referred certain deposits occurring in the Altai Mountains to the Permian period. From a consideration of these plant-bearing deposits the author is led to an interesting generalisation. They indicate a Mesozoic continent on the north comparable with Gondwanaland on the south. Between the two lay Neumayr's Centrale Mittelmeer (the author's Tethys), the marine deposits of which are now traceable in a broad zone stretching from Timor and Sumatra through Tonkin, Yunnan, the Himalaya, Pamir and Hindu Kush to Asia Minor and Europe. Modern Asia owes its origin, therefore, in great measure, to the disappearance of Tethys, the rucking up of its sediments into mighty mountain ranges and the consequent union of Angaraland on the north with the Indian fragment of Gondwanaland on the south.

The third element which enters into the structure of the east Siberian tableland consists of Mesozoic marine deposits, indicating encroachments of the sea from the north at various periods. They have not as yet been traced further south than 62° N. lat., but as the plant-bearing beds of the Angara series have been found in higher latitudes it is certain that the northern boundary of Angaraland must have oscillated backwards and forwards during the Mesozoic period. The marine deposits include representatives of the Middle Lias, Oxfordian, the Volga series and the Neocomian.

The fourth element consists of widespread sheets of basaltic lava. One of these sheets extends from latitude 60° 15′ on the Lower Tunguska to the mouth of the Yenesei. It covers about 6° of latitude and 9° of longitude. These basalts do not stand related to definite volcanic cones. They are of the true plateau type and are thus brought into connection with the basalts of Franz Josef Land and of the Brito-Icelandic province.

On the Lower Tunguska they are associated with deposits of the Angara series, and, although true lavas occur, it is not improbable that the sediments were invaded and sometimes broken up by vast intrusions of a sill-like character, which separated and floated off large masses.

The third section of the work deals with the old nucleus (der alte Scheitel). This extends from the Yenesei above Krasnoyarsk eastwards to the Great Chingan range and as far south as the Gobi Altai. East of Lake Baikal the dominant strike is south-west or west-south-west, west of Lake Baikal it is south-east or east-south-east. These two dominant strikes were produced by pre-Cambrian earth-stresses, but they have determined the directions of the later folding and faulting on the borders of the amphitheatre of Irkutsk and in other regions.

In addition to granites, gneisses and schists, the only rocks entering into the composition of the area in question are fresh-water Tertiary formations and basalts—the latter are allied to those occurring in the tableland of east Siberia. The period of eruptions must have been of great duration, for basalt is found, not only capping the ancient hills of gneiss and schist in horizontal sheets, but occurs also in the beds of existing valleys. The district has been broken up into "horsts" and "sinkings," which are described in great detail from the writings of Russian geologists. Many of the "sinkings" are shown to be of the rift-valley type (Gräben).

The fourth section treats of the Great Chingan range, the plain of the Upper Amur, the Aldan mountains, the Lesser Chingan, Manchuria, Sichoto-Alin, Hokkaido, Sachalin and the Japanese islands. Over the whole of this vast area the author recognises a common type of structure. We will give his views as nearly as possible in his own words.

"In the fruitful plain of the Amur, through the dark primeval forests of the Turkana mountains and the Lesser Chingan as far as the deserts of Sachalin and the great oceanic depths off the Japanese coast, a common arrangement of the leading lines (Leitlinien) finds expression in the convergence of all the curved mountain ranges towards the north of the Sea of Okhotsk. . . . Could we remove the waters of the ocean we should then see the curved rows of islands standing out as mighty mountain ranges. Curve follows curve (Bogen reiht sich an Bogen), and the wonderful agency by which all these curved chains have been produced appears to have proceeded outwards from the central nucleus and to have extended its operations beyond the limits of the modern coast-line."

As the Pacific Ocean is approached, marine deposits of Mesozoic age are met with and traces of the Middle Cretaceous transgression are found in the island of Sachalin. But the plant-bearing beds of the Angara series occur in the plain of the Amur and in Manchuria, thus indicating an extension of Angaraland which has been dropped down in successive steps towards the east by faults and flexures. In spite of this, however, the land area must have increased where the marine Mesozoic strata occur. This increase may have been caused in part by folding, but is probably due, in the main, to a draining off of the sea-waters to fill oceanic depressions formed elsewhere.

Angaraland, which in some parts of Asia goes back to the Carboniferous and in others at least to the Rhætic periods, furnishes an illustration of the permanence of continental areas, though not in the sense in which that expression is usually employed. Since life first appeared on the planet, the phylogenetic thread has never been broken, although evolution has not been continuous and uniform. For the dwellers on the land and in fresh-water the continuity of this thread requires the permanence of continental areas for long periods. Angaraland must, therefore, have been of great importance from a biological point of view. Throughout a large portion of geological time it must have been, not only a retreat for terrestrial and fresh-water forms of life, but also a land capable of sending out colonists as occasions arose.

Enough has now been said to give an idea of the nature of the book and of the method of treatment adopted by the author. The contents of the remaining sections will only be indicated. The fifth and sixth deal with the Altai and the more or less related chains which the author groups under the name of the Altaides; the seventh with the Yarkand-arc and with Iran and Turan; the eighth with the principal ranges of Asia Minor; the ninth and last treats of northern Europe.

Geologists may differ on many points discussed by the author, but no one can complain of the way in which he has presented his views. He is never dogmatic. His

method is to marshal the facts and suggest the conclusions to which they point. One of the most delightful characteristics of the book is the sympathetic interest which the author shows, on almost every page, in the labours of other workers. His sympathies are as all-embracing as the views which he has formed as to the origin of terrestrial features.

The French translations of the first two volumes have already been referred to. The extensive knowledge and great literary skill of M. E. de Margérie, under whose direction the translation has been carried out, are a sufficient guarantee of the excellence of the work. It has evidently been a labour of love with the translators, who have treated their author with that respect which should always be shown in such cases. In two respects the translations are better than the original work. The number of maps and illustrations has been greatly increased (128 as against 43 for the second volume), and the notes, which are voluminous and often very important, are given at the foot of the page to which they refer instead of at the end of each section. Moreover, the notes and references have been brought up to date, but all additions are indicated by the use of square brackets. J. J. H. T.

THE CHEMISTRY OF DYEING.

A Dictionary of Dyes, Mordants and other Compounds used in Dyeing and Calico Printing. By Christopher Rawson, F.I.C., F.C.S., Walter M. Gardner, F.C.S., and W. F. Laycock, Ph.D., F.C.S. Pp. 372. (London: Charles Griffin and Co., Ltd., 1901.) Price 16*s.* net.

THE technology of dyestuffs and dyeing materials has acquired in recent years such a degree of complexity that a dictionary of the subject has become almost a necessity. This want is now supplied by the handy volume before us. Although essentially a dictionary and not to be regarded in the light of a text-book, it nevertheless contains many excellent articles on the chemistry and technology of textile fibres and colouring matters, and should be a most valuable work of reference for all engaged in the arts of dyeing, bleaching, calico printing, paper staining, &c. The book is issued as a companion volume to the well-known "Manual of Dyeing," by Knecht, Rawson and Loewenthal, to which in some respects it serves as a supplement. The methods for the commercial analysis of the various chemicals, mordants and dyeing materials are treated with considerable detail. With regard to colouring-matters a careful system of classification is employed, each group being given a special article, *e.g.*, acid colours, basic colours, direct cotton colours, mordant dyes, &c., and under each of these headings we find a fairly complete list of all the colouring-matters of the particular group at present in use. For further information with regard to individual dyestuffs, each name must be separately consulted. Excellent general articles are also to be found upon indigo, tannin matters, action of light upon dyes, and upon the analysis, valuation and detection of coal-tar colours.

On the other hand, besides a few superfluous articles having little or no bearing on the subject of dyeing (*e.g.*, the headings Acetaldehyde, Acetanilide, Antifebrine, &c.), there are some serious omissions. Thus no method is given for examining the quality of commercial betanaphthol, a matter of much greater importance to the dyer or printer than the isomerism of the sulphonic acids of dioxynaphthalene or of alphanaphthylamine, the reference to which might well be omitted. Again, there is no article upon paranitraniline, but only a cross reference under "Paranitraniline red" to "Azo colours on cotton," where no description is to be found of the properties or methods to be employed in examining for purity this most important product. The same remark applies to dianisidine, only "Dianisidine blue" being referred to under "Azo colours on cotton." The heading of the last-mentioned article should surely have been "Insoluble azo colours on cotton" or "Azo colours produced on the cotton fibre," since all the substantive benzidine colours when applied to cotton might equally be styled "Azo colours on cotton." We also fail to find any reference to sodium sulphide, bronze colours, discharges, persulphates or titanium mordants.

Under the individual colouring-matters there might have been given in some cases a rather fuller account of the special tinctorial properties and degree of fastness to reagents (soap, alkalis, acids, &c.) To provide for these additions considerable space might have been saved by the omission of the names of obsolete colouring-matters and of obsolete names of colouring-matters still used (for instance, aldehyde green, azuline, canelle, heliochrysine, and many others).

A few errors are noticeable in the text, as, for instance, in the article "Janus colours," which latter are stated to be sulphonated basic dyes, whereas in fact they contain no sulphonic group, but are azo-compounds, which owe their solubility and peculiar dyeing properties to the presence of strongly basic ammonium or azonium groups. Again, thioflavine T is given as a derivative of primuline, whereas it is the methylated ammonium compound of dehydrothiotoluidine. The list of manufacturers of colouring-matters given on p. 94 and also opposite to p. 1 is scarcely up-to-date, one of the firms mentioned having ceased to exist, whilst two others have been reconstituted under new names. In spite of the above defects, which can readily be rectified in subsequent editions, the work may be confidently recommended to all engaged in the textile and tinctorial industries as an invaluable lexicon of the subject.

ANIMAL LIFE OF THE CONGO FOREST.

The World of the Great Forest; How Animals, Birds, Reptiles, Insects Talk, Think, Work and Live. By Paul du Chaillu. Pp. xv + 323. Illustrated. (London: Murray, 1901.) Price 7*s.* 6*d.* net.

IN the outlandish and almost unpronouncable native names of animals which form the chapter-headings and recur with wearisome iteration in the text, this volume reminds us of Longfellow's "Hiawatha," although, in our opinion, without affording anything comparable to the pleasure which may be experienced in reading the latter. The author appears to have taken as his model that delightful book of Mr. Seton-Thompson's, "Wild Animals I Have Known"; but if so he has, we think, succeeded in producing only a very poor and feeble

imitation. We have submitted Mr. Du Chaillu's volume to several friends of diverse ages and sexes in the hope of obtaining an opinion as to the class of readers for whose benefit it is specially intended, but in no instance have we succeeded in obtaining a definite answer on this point. One thing is perfectly certain, namely, that no scientific naturalist will gain any information worth having from a perusal of its pages. A lady suggested hat it was like a book for very young children, without being sufficiently amusing.

The author, who firmly believes that animals have a definite language by means of which they communicate their ideas, not only to their own fellows, but to the members of other species as well, had a grand subject before him in describing the life of the denizens of the great Congo forest. But, in our opinion, the conversation he has put into the mouths of the animals is the merest drivel. And when animals, such as leopards antelopes and elephants, have familiar English names, we quite fail to see the advantage of alluding to them, by their negro titles, apparently for the sake of translating them. When an animal like *Tragelaphus euryceros* has no good English name, it is right and proper that its native title—in this case "bongo"—should be employed; but the substitution of "kambi" for antelope is merely confusing. Neither is the work altogether free from absolute errors, while in several instances statements that have been controverted reappear as though they were undoubted facts. As an example of the former class we may refer to the statement on p. 42 that "large flocks of toucans (a bird with a huge bill)" are among the denizens of the Congo forest! As an instance of the second kind, it may be mentioned that (pp. 154–155) the author revives the old story of the gorilla advancing to the attack in the upright posture, beating his breast with his fists. We thought this story had been disposed of by Winwood Reade, who denies that du Chaillu ever saw a living gorilla in the wild state; and, so far as we are aware, no subsequent traveller, with better information at command, has ever said a word in its support.

Again, several of the incidents related appear absolutely incredible. For instance, on p. 95 we have a wonderful picture of a gorilla struggling to free himself from a porcupine on which he had incautiously trodden in his descent from a tree. Bearing in mind the well-known power in wild animals of detecting the presence of other creatures, such an event requires the most convincing testimony to render it credible, and yet it is related without special comment. In another chapter (p. 160) we are told how a python coiled around a tree-trunk "made a tremendous spring" and in an instant was coiled tightly round the body of an unfortunate antelope, which it squeezed to death. How a python could make the spring in question and at the same time disengage itself from the tree around which it was coiled we are not told. As a minor matter, a small inaccuracy in connection with this anecdote may be mentioned. In the accompanying illustration the antelope, which is evidently one of those species of which the females are unarmed, is represented with horns, and yet in the text it is alluded to as a female.

Although it is certainly incorrect to call a land-tortoise a turtle (p. 101), this confusion in terms may perhaps be excused on account of the author's nationality. A similar excuse cannot, however, possibly be made for the statement on p. 266 that "a pack of ugly-looking striped hyænas" advanced into the moonlight. In the first place, striped hyænas are quite unknown in West Africa; and, in the second, the author is refuted by his own draughtsman, who, in the plate on the opposite page, has figured an unmistakable group of *spotted* hyænas. Moreover, if we mistake not, the illustration in question is based, without acknowledgment, on a picture which has already appeared elsewhere.

Neither can we congratulate the author on his views with regard to the *raison d'être* of the coloration of certain animals. It has, for instance, been almost conclusively proved by Mr. Pocock in this Journal (vol. lxii. p. 584) that the striking type of coloration prevalent among the harnessed antelopes is strictly protective. And yet, when referring to the bongo (a member of the group), the author (p. 223) writes as follows:—

"'My beauty is my curse, dear kambis and ncheris,' replied the bongo; 'my yellow colour and my white stripes are my bane, for my enemies, which are also yours, can spy me further and quicker than they do you.'"

Quite apart from the misapprehension of the object of the bongo's colouring, it may strike the reader of this marvellous book that animals thus endowed with the "knowledge of good and evil," as indicated by their conversation, might have been trusted to have devised some artificial mode of concealing themselves from their enemies! R. L.

OUR BOOK SHELF.

Roads; their Construction and Maintenance. By A. Greenwell, A.M.I.C.E., and J. V. Elsden, F.G.S. Pp. vii + 280. (London: Whittaker and Co., 1901.) Price 5*s*.

THIS is a very practical and useful treatise on roads and their maintenance and may be read with great advantage by any intelligent road surveyor. After the dissolution of the turnpike trusts and the handing over of the roads to the charge of the ordinary highway surveyors the main roads of this country became much neglected. The power acquired by County Councils over the main roads, and of District Councils over other highways, has to a certain extent revolutionised the system of road management and a marked improvement has taken place. The use of the cycle and the motor-car, however, demands a much higher standard of efficiency than was ever before required. There is no doubt that the motor-car, as a means of locomotion and transport, has come to stay and will in future fulfil in many cases functions for which now it is deemed necessary to provide light railways and suburban tramways. For these machines to be used with comfort a clear and even road surface, free from mud and loose stones at all times of the year, is indispensable. The best steam-rolled macadamised roads do not fulfil these conditions. In this respect what are termed tar macadam roads, which have been adopted in a great many suburban districts, not only afford a good surface for traction but, being impervious to wet and not acted upon by frost, are clean and more economical than macadamised roads; they are easily repaired and there is an entire absence of loose stones, equally dangerous for horses and deleterious to rubber tyres. The authors speak favourably of this class of road and describe the system as growing in favour, but the cost as given in

the book is higher than that at which they can be laid in the neighbourhood of provincial towns.

Nearly half the book is devoted to a description of the materials used in the maintenance of roads and to their petrology, a subject which should be carefully studied by road surveyors. The authors very clearly show that it is more economical to procure suitable material from a distance than to employ local stones because the first cost is less. There is a very considerable difference in the wearing qualities of different kinds of stone, the reasons for which are clearly shown in the book.

The chapter on the construction of roads gives information which is now little required in this country, but would be of service to a surveyor in the colonies; those on maintenance and cost contain a great many useful and practical hints. The observations under the last head are well worth the consideration of all authorities having charge of the roads of this country. The authors emphasise what has often been pointed out—that good roads can only be obtained by their being placed under skilled management and by maintaining a high standard of efficiency; that roads maintained in good condition cost less to keep up than those which are allowed to be rutty, uneven and covered with loose stones and mud; and that while unnecessary expenditure is to be avoided, the community ought to understand that money well spent in skilled labour and good material is often saved over and over again in time and convenience.

Morphology of Spermatophytes. By John M. Coulter, Ph.D., and Charles J. Chamberlain, Ph.D. Pp. x+188. (New York: D. Appleton and Co., 1901.) Price 1·75 dollars.

FOR a long time past a comprehensive account of the gymnosperms has been greatly needed, for within recent years many important memoirs have appeared which have thrown much light on the structure and relationships of this interesting family of plants. It is, then, with an anticipatory feeling of pleasure that one opens the first instalment of Messrs. Coulter and Chamberlain's book on the morphology of the spermatophytes, seeing that it is entirely devoted to the gymnosperms. And it may at once be said that the authors have done their work well. The book is more than a critical exposition of our present knowledge, for it embodies also the results of a considerable amount of original research on the plants in question. The illustrations are many and good, and include a large proportion of new figures.

The main groups into which the authors divide the family are dealt with in separate chapters, and *Ginkgo* is treated as the representative of a division coordinate with that of the Cycadales or of the Coniferales. The chief fossil types are also considered, and a somewhat detailed and illustrated description is given, based on a study of Dr. Wieland's preparations, of the structure of the strobilus of *Cycadoidea*.

A due proportion is maintained between the space allotted to the account of internal microscopic structure and of general morphology respectively, although naturally the former, which includes the cytological details, comes in for the greater share. Nevertheless, by no means the least interesting chapters in the book are those dealing with the comparative morphology and phylogeny of the gymnosperms as a whole. The authors would regard them as having a monophyletic origin, traceable to a Filicinean ancestry through the Cycadofilices. They base their opinion mainly on the undoubted descent of the cycads from these forms, and on the difficulty of dissociating the other gymnosperms from the cycads. They do not, however, regard the connection between the different groups as a very close one, and suggest that the Bennettitean stock may have served as the starting-point for the cycads, whilst they would refer Ginkgoales and Coniferales to a Cordaitean ancestry.

They judiciously refrain from dealing very specifically with the Gnetales. The three constituent genera, Gnetum, Tumboa (a name which one regrets to see displacing Welwitschia) and Ephedra differ so widely, both from each other as well as from the rest of the main groups, that they can only be regarded as isolated remnants of some ancient line, the affinities of which it is as yet impossible to do more than guess at.

A short sketch of the geographical distribution of the gymnosperms brings the volume to a close. The authors are to be congratulated on the ability they have displayed in producing a work which is valuable, not only as a text-book, but as a real contribution to science.

Guide Pratique pour les Calculs de Résistance des chaudières a vapeur et l'Essai des matériaux employés. Par G. Huin et E. Maire, avec la collaboration de H. Walther Meunier. "Actualités Scientifiques." Pp. vi+67. (Paris: Gauthier-Villars, 1901.) Price fr. 2.75.

THIS book, consisting of a collection of data and tables relating to boiler construction, is a translation of those adopted by l'Union Internationale des Associations de surveillance d'Appareils a Vapeur, which are in common use in Germany.

Part i. is devoted to formulæ, supplemented by extensive tables, for the determination of the dimensions of the principal parts of boilers.

Part ii. gives the rules relating to the selection of the material and specifies the tests to be used in any case.

The whole book covers about the same ground as the Board of Trade or Lloyd's rules for boilers, considered in greater detail and the calculations assisted by tables. The latter include, thickness of flue plates, for various lengths, diameters and pressures, thickness of shell for iron and steel, with various joints, dimensions and pressures, and the thickness of flat plates under various systems of staying.

The formulæ given are in nearly every case of the same form as those used here, but generally speaking the constants are such as to give slightly smaller dimensions.

This is due to the use of an average factor of safety of 4·5 compared with 5 required by the Board of Trade.

For the thickness of flue the formula given is Bach's

$$t = \frac{p.d}{k}\left(1 + \sqrt{1 + \frac{p}{k'}\,\frac{l}{l+d}}\right) + k'',$$

which should be applicable for a much wider range than our simple

$$t = \sqrt{\frac{p.l.d.}{k}}.$$

There is very little that is not to be found in an ordinary engineer's pocket book. F. H. H.

Ein Wort über den Sitz der vulkanischen Kräfte in der Gegenwart. (*Mittheilung aus dem Museum für Völkerkunde zu Leipzig.*) Von Alphons Stübel. Pp. 15; 9 figures in text, 1 coloured plate. (Leipzig: Max Weg, 1901.)

AS such a difficult subject cannot be discussed in a short notice, it must suffice to give the author's conclusions. He regards the globe as originally a liquid mass, which has become incrusted through loss of heat. This crust at first would be thin and incapable of offering an effective resistance to the struggles of the liquid interior. It would be ruptured at countless points, great floods of lava would be outpoured, without, however, the building up of important volcanic hills. At this epoch the earth may have even been surrounded by a photosphere. In the second stage the crust layer thickens to about 10 kilometres—the phenomena are similar in kind, but correspondingly reduced in extent. In the third stage the crust layer is about 25 kilometres, and the places of

discharge from the liquid interior are fewer. Eruptions come from local reservoirs in the generally solid crust, which, however, may have a communication from beneath with the inner mass. In the fourth stage, when the crust layer approaches 50 kilometres, there is a further decline in number, though an increase in violence, of discharges from the liquid interior, but the activity of the reservoirs is maintained, and henceforth these are the main sources of vulcanicity. That is the age of catastrophic eruption, and the photosphere is disappearing. The next stage continues the cutting off of direct communication with the interior, separation takes place in the masses of magma, and local eruptions are still very violent. This phase may correspond with that stereotyped in the moon. The sixth stage begins, the seventh continues, the deposit of sediments, during which metamorphism is active in the lower beds, thus forming an outer skin to the crust layer. Eruptions continue to affect a plateau type in the earlier of these; the volume of the reservoirs is gradually being reduced, as well as the communications with the more distant interior of the earth. The eighth, in which the liquid reservoirs are few and small, and communication from within any part of the thickened crust layer to the interior very rarely exists, is the present period.

Photographic Cameras and Accessories. Edited by Paul N. Hasluck. Pp. 160. (London: Cassell and Co., Ltd., 1901.)

IT is not often that one meets with amateur photographers who possess cameras made with their own hands, because at the present day instruments can be obtained at such prices that the pocket of even the most modest purchaser can be suited. This is, however, no reason why a camera should not be home-made; and, in fact, besides affording the worker a very pleasant occupation, especially anyone who is interested in carpentry, it redounds to his credit if he turns out a good-looking and serviceable camera and produces first-class pictures with it.

The contents of this little book will afford a very ready and serviceable guide to anyone who wishes to try his hand in this direction, and supply the reader with concise information on the details of the subject of which it treats. As we are told in the preface, the matter consists essentially of a digest of material contributed by a professional photographer to a weekly journal, so that the instructions should be, and are, thoroughly practical. The text is accompanied by a great many working drawings, 241 in number, and deals, not only with the construction of the bodies of cameras, but with dark slides, shutters and stands.

Trattato elementare di Fisica. Da Oreste Murani. Vol. iii. Optics and Electricity. Second edition. Pp. xxi+675. (Milan: Ulrico Hoepli, 1901.)

THIS is a descriptive treatise in which the experimental phenomena in optics and electricity are described and the apparatus used for exhibiting or applying them are illustrated by no less than 593 woodcuts. It is essentially non-mathematical in its treatment, the few formulæ included in the text in connection with such laws as the law of refraction of light and Ohm's law involving no calculus and merely the notation of trigonometry. In regard to modern electrical discoveries and notions, Prof. Murani has brought his treatise very much up-to-date, and the experiments of Righi, Lenard, Hittorf and Hertz on electric discharges, the Röntgen and Becquerel rays, Kerr's, Hall's and Zeeman's phenomena, Tesla's experiments, wireless telegraphy, the coherer and the Wehnelt interrupter, afford instances of the many recent innovations which are described at some length. In the concluding sections the author expresses doubts as to the efficacy of lightning conductors of the old style when the effects of electromagnetic induction are taken into account. The book should be useful both as a class-book in technical colleges, for which purpose it is especially written, and as a work of reference for general readers who wish to acquire some notion of modern electricity and optics without entering into abstruse theories or technical minutiæ.

G. H. B.

A First Course of Practical Science. By J. H. Leonard, B.Sc. Pp. xii + 138. (London: John Murray, 1901.)

EXCELLENT courses of practical work in the rudiments of mensuration and physics are now available in several text-books, but there is still room for volumes like the present one. The exercises described are suitable for quite young beginners, and they will serve the double purpose of applying the pupils' knowledge of arithmetic and developing a scientific frame of mind. Simple measurements of length, area and volume, and calculations (particularly with decimals) referring to them, form the subjects of the opening chapters. Following these are laboratory exercises on weight and centre of gravity, relative weight, atmospheric pressure, thermal expansion, thermometers, latent heat, filtration, solution and distillation.

The experiments are described concisely and are well arranged, so that a pupil of average capacity could perform them without much assistance, and at the same time would acquire clear ideas on fundamental principles. We do not like such expressions as "Have all liquids got a latent heat? Have all gases got a latent heat?" but that is a detail. As a whole the book is satisfactory, and, with others of the same kind, will assist the movement in favour of introducing scientific measurements in early stages of instruction in schools. Dr. Gladstone contributes a short preface.

Coltivazione delle Miniere. By S. Bertolio. Pp. vii+284, with 96 figures. (Milan: Hoepli, 1902 [*sic*]. Price L. 2·50.)

THIS is one of the numerous manuals published by Hoepli of Milan; it contains a useful little epitome of the art of mining. It is not fair to expect too much from a book costing only 2*s*., and consequently one must not carp too loudly at the absence of detailed descriptions and figures of certain important mining appliances. Steam shovels and dredges, which play so weighty a part nowadays, are merely mentioned by name, and hydraulic mining is dismissed in a couple of lines. This defect should be remedied in a second edition, for it is well even in a small manual to impress upon the student the great importance of all mechanical methods of excavation.

On the other hand, the author deserves credit for his picture of the well-marked projecting outcrops of three parallel lodes at Montevecchio in Sardinia; the student has not always the opportunity of seeing such a fine example in the field. Mistakes in foreign words are too frequent, and when the simple name of the inventor of the safety-lamp is spelt "Dawy," the Englishman feels aggrieved; however, all nations are treated alike, for the author is not absolutely faultless in his own tongue.

The Ballads and Shorter Poems of Frederick V. Schiller. Translated into English Verse by Gilbert Clark, M.A. Pp. xv+408. (London: Williams and Norgate.)

SCHILLER'S philosophical writings have admirers in the world of science, and this translation will contribute to the wider appreciation of his poems among people unable to read them in the original. The series of poetical parables and riddles referring to natural phenomena, and the verses on astronomy, astronomers, nature knowledge and transcendental philosophy are of interest to scientific minds.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

Humus as a Preservative against Frost.

I HAVE just read a French translation, by my old friend Prof. Henry of the Nancy Forest School, of Wollny's classic work on the decomposition of organic matter. In it I find the statement that spring and autumn frosts are dangerous on peaty soils only when the surface of the latter is dry. Wollny gives no illustrations of this law, but I recently observed one in my garden at Coopers Hill.

Last September I dug up several rose beds on my lawn and sowed them with grass seed, which has produced a fine crop of young grass. This I carefully watered, and the soil in the beds was well trenched and covered with decomposed leaf mould before the seed was sown. The rest of the lawn has not been trenched, probably for thirty years, and the soil under the grass in it, a stiffish loam, is now singularly dry for the time of the year.

On the morning of December 6 there was a slight frost, 31° F. being registered six inches above the grass. At 8 a.m. the lawn was white with rime, except on the new grass, which remained green.

This must be due to the fact that the moist, well-trenched humus soil under the new grass was able to conduct heat from below and thus kept the air in contact with it above the freezing-point, while the dry, compact loam under the old turf could not supply sufficient heat to the old grass to preserve it from freezing. Dry humus, according to Wollny, has a low specific heat and is a bad conductor, while wet humus has a high specific heat and is a good conductor of heat. On another occasion, when snow fell, it melted much sooner on the new grass than on the rest of the garden.

As a further illustration of Wollny's law I may cite the fact that water is let on to cranberry swamps in Carolina when frost is feared during the blossoming period, and also that in north-west India, on clear evenings when frost is feared, vegetable gardens and sugar-cane plantations are irrigated in order to obviate danger from frost.

It is also well known in Germany that if a sphagnum peat bog is to be reproduced, a thin layer of peat must be left at the base of the bog after the upper peat has been removed, and this layer kept carefully under water, as otherwise the drying up and consequent freezing of the peat will kill the moss.

Slight frosts are very prejudicial to vegetation in sub-tropical forests, and, when frost is imminent, the precaution of trenching the soil, removing weeds and irrigating cultivations is extremely important for young sugar-cane and other crops.

Coopers Hill, December 8. W. R. FISHER.

A possible new Petroleum Field near Naples.

WHEN sailing from Posilipo to Sorrento on August 31 last, at about four or five miles from the nearest land of the Sorrentine Peninsula we encountered a most unmistakable smell of petroleum, just as if a leaking petroleum tank steamer had crossed our bows a few moments previously. Two tracks of the smell were distinctly noticeable, the one at lat. 40° 41′ 30″, long. 14° 19′, and the other at lat. 40° 42′, long. 14° 18′ 30″. A moderate *furano* or southerly wind was blowing at the time, so that in all probability the source of the petroleum was somewhat to the south of the position given.

The only other record of a petroleum source in the immediate vicinity of Naples is that of the Balneum Olii Petrolei, or *bagno del petroleo*, which formerly existed near the Stufe di Nerone, between Pozzuoli and Baia. This petroleum bath has now quite dried up, but formerly was much praised by mediæval writers for its curative powers in cases of leprosy and cholera, and also because its waters caused the limbs of bathers to rejoice in new found vigour. The last mention of this petroleum bath was by Bartolo in 1679. In the southern Italian provinces petroleum has been found in considerable quantity at San Giovanni Incarico and at Pico in the valley of the Liri in the district of Gaeta. Indeed, in 1878, 600 tons, or almost all the Italian petroleum, came from this source alone. In the last two decades the annual output has much diminished and has become insignificant as compared with the increased production of the wells in northern Italy. Petroleum has also been stated to occur at Tramutola, on the Gulf of Taranto, and asphalt is recorded from the east side of the Abruzzi, about twenty miles from Pescara on the Adriatic (Redwood).

The depth of the water (80 fathoms) at that part of the Bay of Naples where the smell was noticed is too great for the collection of the petroleum to be commercially practicable. But the long-continued escape of petroleum in the immediate vicinity of the Apennine Limestones of the Sorrentine Peninsula is an indication that deep borings might be successful and might one day yield as profitable a supply of petroleum as the borings in northern Italy. The petroleum fields of the north of Italy near Bologna and Piacenza extend along anticlinals of the Tertiary Limestone, and therefore are geologically similar in many respects to the country in or near which the newly discovered petroleum spring occurs. R. T. GÜNTHER.

Magdalen College, Oxford, December 13.

Automatic Actions.

As Mr. Dixon points out (p. 102), a mental process frequently repeated becomes automatic.

The impulse passes readily along a path in the brain-cells previously frequently traversed by similar impulses, much as a man who revisits the haunts of his youth may, while in a brown study—that is, while abstracting his mind from conscious direction—find his way unerringly through cross-paths, whereas if he had tried to think out his route he would probably have gone astray.

Mr. Dixon's remarks on the different modes of rising of the horse and cow suggest an explanation. I have hitherto regarded the explanation as due to anatomical differences, but the anatomy of animals has been modified by habit and habit by the necessities of environment.

The horse, which couches on the plain in long grass, rises head first. This method gives him an early view over the surrounding grass and keeps his hind legs (his chief propellers) well under him.

The cow, whose natural lair is under low-hanging boughs, rises tail first. This method allows her till the last moment to keep her eyes upon and her horns presented to an approaching foe. W. BENTHALL.

December 7.

VARIATION IN FOWLS.

THE recurrence of the large shows of the different varieties of domestic poultry which occurs at this season of the year gives an admirable opportunity to those interested in the subject of studying the characters of the different breeds, and the almost innumerable varieties produced by crossing them. The study of variation has been a favourite pursuit of mine for more than half a century. When Darwin was preparing his works on the "Origin of Species" and on the "Variation of Animals," he was surprised to find, when I was introduced to him by Yarrell at a poultry show, that I had made a large collection of crania of the different varieties. Of these specimens he availed himself largely in his work on "Variation," in which I had the great pleasure of assisting him. I can, therefore, speak with considerable precision of the great change which has taken place in the breeds of poultry during the last fifty years. The figures in Darwin's large work on the "Variation of Animals" were all drawn from birds selected by myself as the most typical specimens of the various races, but I may state that there is not a single figure shown that would not now be repudiated as utterly unworthy of exhibition by the present fanciers, every variety having had its fancy points so greatly increased. To take the figure of the Spanish fowl (shown in chapter vii.), characterised by its white face and large white ear lobe. This represents a fowl which now hardly exists, for the comb has been increased to at least four times the area of that shown by Darwin; the white skin on the face has been so much enlarged as to cause the birds when aged to become

blind unless the skin is cut away. The ear lobe, enlarged in the portrait to many times its natural size, has been again increased, becoming in some cases more than seven inches in length by four or five in breadth when spread out, and offering an area of some thirty square inches. These characters have been carried to such an excess that the breed has become altered from an abundant layer of large eggs into a practically useless variety, and at many shows where they were formerly the most numerous birds exhibited they are now absent, having been, as it were, improved by the fanciers almost out of existence, their laying qualities and utility having almost entirely disappeared. At the Crystal Palace show recently held, where nearly 4000 fowls were exhibited, less than a dozen Spanish put in an appearance, and at the show just opened at the Alexandra Palace, where there are no less than 281 classes for the different varieties of fowls, Spanish are conspicuous by their absence.

Darwin in his list enumerates thirteen varieties of fowls as known to him, namely Game, Malay, Cochin, Dorking, Spanish, Hamburg, Polish, Bantam, Rumpless, Creepers, Frizzled, Silky and Sooties, with their sub-breeds, which he also mentions. In the last Crystal Palace show we had no less than 240 classes, which included all the varieties shown. The old English Dorking breed was the one which has been least changed or modified during the last fifty years, having been merely increased in size. Cochins, which were imported, not, as the name implies, from Cochin China, but from Shanghai, many hundred miles distant, were originally characterised by profuse fluffy plumage, very small wings, which rendered them almost incapable of flight, a small amount of feather on the tarsus or scaly part of the leg and on the foot. This breed, with all the others, was regarded by Darwin as descended from one wild species, the jungle fowl, *Gallus ferrugineus*. This was one of the very few points in which I differed from my honoured master. I believe that the Cochin descended from another species of wild Gallus, which in consequence of its scant power of flight had all passed into a state of domestication and which has long ceased to exist as a wild bird. My opinions are based upon the fact that there is considerable structural difference between the Cochin and the varieties of the *Gallus ferrugineus*. In the Cochin, the axis of the occipital foramen is greatly elongated perpendicularly; in the ordinary fowl its long axis is horizontal. In the Cochin, as originally introduced, a deep median furrow is visible down the frontal bone, which is not present in other fowls. These points could not have been produced by artificial selection. Then again, the voice of the bird was utterly distinct from that of any descendants of *Gallus ferrugineus*. The habits of the birds, as originally introduced, were exceedingly distinct from those of our domesticated species. At the present time the Cochin threatens to become as nearly extinct in England as the Spanish, having been bred for fancy points, and the tendency to produce feather on the lower extremities has been so enormously exaggerated that in prize specimens the feet are as nearly full plumaged as the wings.

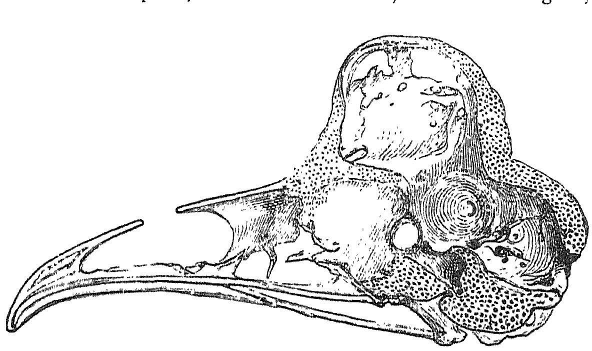

FIG. 1.—Section of skull of crested fowl.

In Darwin's time one of the most remarkable breeds raised by fanciers was the crested, or, as they were then called, the Polish breeds, characterised by a very large tuft of feathers on the top of the head. I paid much attention to these breeds from the singular anatomical peculiarity which they offered; the cranium became greatly modified, the crest taking its rise from a very large bony protuberance of the frontal bones. This in well-developed specimens contained more than half the brain, which, instead of retaining its normal form, became of an hour-glass shape. Specimens of these remarkable skulls were shown by me at the Zoological Society in 1856, figured by Darwin in "Variation" and in my "Poultry Book," from which the accompanying engraving is reproduced. These birds have almost gone out of fashion, there being now no classes for them at the Crystal or Alexandra Palace shows.

If we compare the varieties of poultry as shown at present with those that existed in Darwin's time, we find that the offer of prizes, often of great value, at poultry shows, has induced, not only the formation of innumerable new breeds obtained by crossing and selection, but has led to the exaggeration of the salient points of every variety, as far as is actually possible. If I may presume to quote my own book, on "Table and Market Poultry," I would state: "The fancier has not even a standard of beauty which he regards as final. The greater the extent to which he can make the specimens he produces excel others in fancy points is the object at which he aims; consequently hideous monstrosities are not unfrequently produced and exhibited, the only advantage of which, from a scientific or practical point of view, is to prove the extent to which living organisms are variable under the influence of artificial as opposed to natural selection." W. B. TEGETMEIER.

FRESH LIGHT ON THE ANTARCTIC.[1]

THIS is the second narrative of the cruise of the *Southern Cross* and of the first winter spent on Antarctic land. It is written for the same class of the general public as its predecessor by the commander of the expedition. Mr. Bernacchi is, however, a man of scientific training, and although the exuberance of his literary style is sometimes in excess of the strict requirements of science and some of his words do not occur in the dictionary, we are able to gather a few new facts and some corrected impressions from his book. Unfortunately, the book has been written in a hurry, for which there is at least the excuse that the author has set out once more to the South Polar regions; but in one place he acknowledges, and in many places leaves it to be discovered, that he was unable to consult his companions on points that require some explanation.

It is not everyone who can write a book so as to exclude the irrelevant and make the essential attractive to the average reader; yet this, we think, should be the chief justification of a narrative, and especially a second narrative, of an expedition that was in a considerable degree scientific.

The book is divided into two parts, "Narrative" and "Scientific." The narrative need only be referred to in order to remind the reader of the necessary dates which are usually difficult to gather in such works. The *Southern Cross* left London on August 22, 1898, reached Madeira on September 4, left on the 5th, touched at St. Cruz on

[1] "To the South Polar Regions. Expedition of 1898–1900." By Louis Bernacchi, F.R.G.S. Illustrated from photographs taken by the author. Pp. xvi + 348. (London: Hurst and Blackett, Ltd., 1901.) Price 12s. net.

the 7th, stayed a day at St. Vincent (date not given), reached Tasmania on November 27, ninety-seven days out from London, and sailed on December 19 for the Antarctic regions. The ice-pack was entered on December 31, the Balleny and Russel Islands were seen while fast in it, and on February 10, 1899, the ship, having been unable to penetrate the belt of ice, came out again on the northern side. She entered it once more on the 14th, got through in six hours, and reached Cape Adare on the 17th. On March 1 the ship left for Australia after landing the expedition, and on January 28, 1900, she returned; but no particulars are given, either here or in Mr. Borchgrevink's book, of her two voyages through the pack. On February 2 the whole party started southward in the ship; they landed on Possession Island, in Wood Bay, at the foot of Mount Melbourne, on Franklin Island on February 10, at Cape Crozier, close under Mount Terror, and finally upon the ice-barrier itself in 78° 34′ S. on the 17th. The ship remained moored to the ice-barrier all day on the 18th, and on February 19 the return voyage began along nearly the same route as had been taken coming south. The weather was very boisterous, and the remarkable fact is now stated, we believe for the first time, that no ice whatever was met with and there was absolutely no pack to go through. Auckland Island was reached on March 21, 1900, and here the expedition may be said to have completed its labours. It would have been highly important if the log of the *Southern Cross* were published in full, so that there might be no uncertainty as to the exact dates of reaching the various points, and in particular as to the condition of the sea-ice.

Mr. Bernacchi very clearly indicates the character of the Antarctic summer, a period of low temperature and high wind, with very frequent fogs and rare intervals of clear weather. He states definitely that Mount Erebus was never clearly visible, merely a glimpse having been had of it, too short to allow a photograph to be taken. On February 19 the ship as she lay at the ice-barrier was beset with young ice, and broke through with such difficulty that another day's delay would have meant another year.

The specially "scientific" part of the book is an appendix, though not so called, of 50 pages. It treats of the climate of the South Polar regions, terrestrial magnetism, zoology, geology, astronomy, and concludes with miscellaneous notes and a short glossary of ice-terms.

In discussing the climate, Mr. Bernacchi founds his remarks on a preliminary study of the observations taken at Cape Adare, which have been discussed at the Meteorological Office and are to be published by the Royal Society. The winter was not nearly so cold as at continental stations within the polar circle in the northern hemisphere, the absolute minimum recorded being $-43^{\circ}\cdot 5$ F. and the mean minimum of the coldest month, August, $-22^{\circ}\cdot 7$ F. On the other hand, the summer is very cold, the absolute maximum being $48^{\circ}\cdot 7$ and the mean maximum of January (the warmest month, apparently, although there are no values for February) $37^{\circ}\cdot 0$; the mean temperature of this midsummer month was only 33°, and the absolute minimum 25° F., but a short distance further south minima below zero Fahrenheit were observed early in February. The most remarkable feature, however, was the wind. Windroses are given for each month of the year, showing that the south-eastern quadrant of the horizon has an immense preponderance of winds in every month and a monopoly of gales. This is assumed as strong evidence of the existence of a great continental anti-

FIG. 1.—The Slate Formation in Robertson Bay. (From "To the South Polar Regions," by L. Bernacchi.)

cyclone to the south; and no doubt that theory is attractive and has much evidence in its favour. But the gales which burst from the E.S.E. or S.E. were invariably accompanied by a sudden and great rise of temperature, which in eleven cases cited ranged from nearly 14 to more than 44 Fahrenheit degrees. This wind beat against Cape Adare from the level surface of the frozen sea, and does not suggest a Föhn effect or an origin in the icy heart of a South-Polar anticyclone. Does it not rather indicate the passage of a cyclone centre to the north and the sweeping in of air from the warm surface of the sea south of Australia? An anticyclone brooding over the southern land would probably tend to turn wandering cyclones eastward along its margin, and the two explanations are thus to some extent compatible.

The magnetic observations are being worked up by Dr. Chree; from the preliminary figures quoted here we note that the greatest dip observed was 88° 2′ 37″ at the base of the Mount Melbourne, but it is pointed out that the magnetic dip all along the coast of Victoria land was less than at the time of Ross's expedition. The zoological chapter contains no information; it merely quotes a few descriptive remarks of the vertebrates noticed, all of them of known species. The invertebrates are not referred to, but the whole of the zoology of the expedition is being worked up at the British Museum.

There was no geologist on board the *Southern Cross*, but the non-technical descriptions of rocks in the narrative and the reference to the determination of specimens by Mr. J. T. Prior show that the geologist on the *Discovery* will have a splendid field in which to win his spurs, though the alternation of volcanic and metamorphic rocks does not suggest the probability of sensational fossil finds.

The difficulty of making astronomical observations in high southern latitudes is feelingly dealt with. The determination of longitude was particularly difficult, the only really satisfactory attempt to fix Cape Adare being by an occultation of Saturn by the moon. Refraction was a never-ceasing trouble, for the horizon was frequently very far from being a straight line. Thus on one occasion Mr. Bernacchi says (p. 156):—

"Huge icebergs to the north which must have been quite thirty miles away, and which, under ordinary circumstances, were invisible even from the huts, were elevated by refraction to a height on a level with the top of Cape Adare, the height of which is nearly 900 feet. The display, it can almost be called so, was ever changing in appearance; sometimes one part of the horizon was elevated, then this would subside and another part rise up. At this time of the year the coast line in the direction of Yule Bay and Cape North, nearly 100 miles away, was frequently seen on clear days in consequence of the great rarity of the atmosphere."

A comparison of Mr. Borchgrevink's and Mr. Bernacchi's narratives yields several minor points of interest to which it is unnecessary to refer; but we find the resultant of reading both books is an increase of our opinion of the commander's power of overcoming difficulties and of the physicist's scientific zeal and loyal cooperation.

THE SPECTRA OF BRIGHT SOUTHERN STARS.[1]

THE well-known researches on stellar spectra which have been carried on for many years at the Harvard College Observatory under the direction of Prof. E. C. Pickering have now reached another very definite stage. The publication of the Draper Catalogue in 1890 put us in possession of the general characteristics of the spectra of more than 10,000 stars, and this work will long remain a monument to the skill of Prof. Pickering, besides fulfilling its original purpose as a lasting memorial of Dr. Henry Draper (NATURE, vol. xlv. p. 427). Following this, a detailed description and classification of the spectra of 681 of the brighter stars north of −30°, based upon photographs taken with relatively large dispersion, was published in 1897 (NATURE, vol. lvi. p. 206). The establishment of a branch observatory in the southern hemisphere, at Arequipa, Peru, has enabled Prof. Pickering to extend the inquiry to the southern stars, with results described in the volume under notice.

The prismatic camera has been employed throughout the whole investigation, and the accumulation of so much valuable material in so short a time must be attributed in great measure to the many advantages which this instrument possesses over the slit spectroscope when radial velocities are not in question. At Arequipa the 13-inch Boyden telescope has been employed in conjunction with one, two or three prisms, giving spectra of lengths 2·24, 4·86 and 7·43 centimetres respectively from $H\epsilon$ to $H\beta$. The number of photographs taken from November 29, 1891, to December 6, 1899, was no less than 5961, with an average exposure of one hour; but as many of the spectra were photographed several times the number of individual stars investigated is smaller, namely 1122. In these are included all stars south of declination −30° which have a photometric magnitude of 5·0 or brighter, numerous fainter stars in the same region, many stars between the equator and −30°, and a few northern stars.

Dr. McClean's magnificent series of photographs of the spectra of southern stars had prepared us to find that the spectra are not less diverse than in the northern hemisphere, and it became a point of much interest to see if the greater number of stars now studied necessitated any revision of the classification proposed for the northern stars alone. This question of classification, it will be understood, is one of the greatest importance, since the ultimate aim is not merely to enable the astronomer to place his photographs in their proper pigeon-holes, but to indicate the various stages of star life. It is an unfortunate circumstance, however, that not one of the classifications hitherto suggested has met with general acceptance, but the reason for this may perhaps be traced to a want of confidence due to the frequent revisions which have been necessary as the more delicate features of the spectra have been brought to light by the use of better instruments. However that may be, it is sufficiently remarkable that the old classification which we owe to Rutherfurd and Secchi is almost the only approach to a universal language of stellar spectra, in spite of the fact that it is hopelessly inadequate to deal with modern data.

For the present discussion Miss Cannon has found it convenient to revert to the nomenclature of the Draper Catalogue, but with modifications to suit the intermediate classes revealed by the use of greater dispersion. It is pointed out that in most cases the symbols can be readily translated into the numbers previously applied to the groups of northern stars, but it would surely have been more convenient to have two such closely associated investigations expressed in the same language. However, the classification is fairly adequate, but as the nomenclature is too cumbersome to be likely to come into common use it is unnecessary to describe it in detail.

The great majority of the 1122 stars discussed in this publication can be arranged in a sequence, agreeing in the main with that arrived at in the case of the northern stars, but permitting its extension towards the beginning of the series. The investigation of the northern stars led Prof. Pickering and Miss Maury to commence the

[1] "Spectra of Bright Southern Stars, Photographed with the 13-inch Boyden Telescope as a Part of the Henry Draper Memorial, and Discussed by Annie J. Cannon under the Direction of Edward C. Pickering." (*Annals* of the Astronomical Observatory of Harvard College, vol. xxviii. part ii.)

series with stars of the "Orion" type, which by transitional stages were succeeded by the Sirian and solar stars, and then by stars with fluted spectra. An important advance has now been made in establishing the place of the bright-line stars of the Wolf-Rayet class as immediately preceding the stars of the Orion type. The spectra themselves do not indicate whether the series begins or ends with the bright-line stars, but that it begins with them is probable from their general spectroscopic resemblance to nebulæ. One piece of evidence on this point does not seem to have been followed up as closely as its importance calls for; on p. 141 it is stated that the green line λ 5007, which has hitherto been regarded as specially characteristic of nebulæ, is sometimes present in the Wolf-Rayet stars. If this be the case there would seem to be no possible doubt that the bright-line stars are the first results of nebular condensation; but we find no further reference to this interesting point in the detailed description of spectra.

A considerable part of the volume is occupied with detailed accounts of typical spectra which are exceedingly valuable, and the descriptions of the various classes of bright-line stars will be especially welcomed by other investigators. The discussion apparently indicates that the forms most closely resembling the planetary nebulæ are those in which there are no dark lines in the spectra, while succeeding stages are represented by stars in which dark lines are gradually introduced, until finally the Orion type of spectra, usually consisting wholly of dark lines, is reached.

Three catalogues are given. One of them brings together the stars belonging to each of the spectroscopic groups; another is a general catalogue with the stars in order of right ascension; and still another is an index to the stars, both northern and southern, which have letters assigned to them. In the last named, the nomenclature previously employed for the spectra of the northern stars has been converted into the new system adopted for the present volume. It will thus be seen that no pains have been spared to provide every convenience for those who may have occasion to use the catalogues for purposes of reference.

Besides the catalogues there are several tables of the wave-lengths and intensities of the lines in the various sub-groups of the bright-line stars and stars of the Orion type, and in some cases the wave-lengths extend into the visible spectrum as far as D_3. It is only in the more obvious cases, however, that an attempt has been made to assign origins to the lines, but the determination of origins is perhaps wisely avoided unless the work of a laboratory goes hand in hand with that of an observatory. Still, one cannot help regretting that the tables of enhanced lines published by Sir Norman Lockyer have not been utilised in this connection, especially as there are distinct indications that some apparent difficulties might thus have been removed. Thus, on p. 186 it is stated that in the spectrum of α Cygni there are two lines of greater wave-length than H_β, which are "well marked and agree in position and intensity with the helium lines 4922·1 and 5015·7 as present in the spectra of the Orion stars. It appears far more probable, however, that these are solar lines." The probability is that these lines, like so many others in α Cygni, according to Sir Norman Lockyer, are enhanced lines of iron, their wave-lengths being 4924·1 and 5018·6, which are curiously near to two prominent lines of helium. It seems very likely also that a reference to enhanced lines would throw much light upon such spectra as that of η Carinæ (Argûs) and possibly upon other "peculiar" spectra.

Again, the descriptions of typical spectra clearly show that among the first additional lines introduced in passing from the Orion to the Sirian stars are 4233·6, 4173·6, 4179·5 and 4385·2, which are doubtless enhanced lines of iron at corresponding wave-lengths; these lines, however, are simply regarded as "characteristic solar lines" (p. 154), although as the true solar stage is approached they cease to be conspicuous.

Among many interesting results, it may be mentioned that a few stars have been found to have spectra resembling that of α Cygni, which hitherto had been practically the only representative of its type. The detailed description of the spectrum of γ Velorum (Argûs), the brightest star of the Wolf-Rayet type, is also worthy of special mention.

The volume is enriched by three fine plates, one of which illustrates six typical spectra; another shows six examples of "peculiar" spectra, including ζ Puppis and γ Argûs; while the third exhibits, by direct enlargements of portions of three spectra, the vast amount of fine detail portrayed by the prismatic camera.

Great praise is due to all who have taken part in this magnificent piece of work.

A. FOWLER.

FOREIGN INDUSTRIAL COMPETITION AND TECHNICAL EDUCATION.

ON the occasion of the prize distribution to the students of the Goldsmiths' Institute at New Cross, on December 12, Mr. Balfour made some remarks on technical education and its bearing upon foreign competition which are worthy of comment. With the optimism which characterises this statesman's utterances, he expressed the opinion that although

"unquestionably there was a time when we ignored the great need for a thorough scientific and artistic training in connection with our great industries," yet he was "not sure whether we are not now verging upon the opposite danger to that which we ran a few years ago," for there was a tendency, in some quarters at all events, to "talk as if the only thing which had to be done to restore British manufactures to their pristine condition in the world's industries was a manipulation of our methods of education."

Mr. Balfour then went on to say that he placed no faith whatever in the arguments which he constantly heard indicating the relative decay of British manufactures, and deprecated the tendency, which he characterised as a "dangerous fallacy," of supposing

"that every successful and prosperous manufacture started by any other nation but our own was a kind of robbery committed on British trade," for we ought to be satisfied with the reflection that, "broadly speaking, the prosperity of one nation conduces to the prosperity of all nations, and we are not poorer, but richer, because other nations are rich."

As was to be expected, these self-satisfying sentiments met with full approval; but the distinguished speaker proceeded to introduce a little rift into his lute when he said,

"I look with perfect serenity upon the general increase of the world's wealth as long as I can be assured that in this country we organise our labour in such a manner that the best workman gets the greatest remuneration; . . . . that there is no lack of well-trained and skilled persons in all branches of manufacture; and last, but not least, that those who lead industry in this country, the capitalists, the manufacturers and the managers, show that flexibility, that power of adaptation to the ever-changing needs of the world which is, of course, an absolute necessity if we are to make the best of the great advantages by which we have been enabled to meet the demands of the world in the matter of manufacture."

Mr. Balfour is apparently already assured on these points, but can this attitude be accepted by those who view the future of their country from a higher standpoint than that of an armchair political economy? Are we to stand calmly by and see the supremacy in industry after industry transferred to foreign shores until at last, like the inhabitants of a Gilbertian island, we are re-

duced to living by taking in each other's washing? The economical laws which apply to nations are much the same as those which govern individuals, but we have yet to meet the man who takes pleasure in his competitors' wealth on the ground that it conduces to his own prosperity. What is to be gained by burying our heads in the sand and announcing that no danger is in sight? With nations as with individuals, progress must cease when self-complacency begins.

Considering first Mr. Balfour's last proposition—Do the leaders of industry in this country show that flexibility and power of adaptation to changing needs which is absolutely necessary for meeting the demands of the world in manufactures? If we are to credit the statements of experts in almost every branch of trade, and the facts which are patent to our eyes, we must conclude that they do not. In the chemical industries, where, before all others, adaptation to rapid changes and the immediate utilisation of new scientific discoveries are of paramount importance, we have not only lost the supremacy we once possessed, but we stand at present in great danger, in the organic-chemical manufactures at any rate, of falling out of the running altogether. The chemical trade of Germany, built up almost entirely during the last forty years, now amounts to an annual value of about 50,000,000*l.*, of which about 10,000,000*l.* represents the value of the production of colouring-matters, synthetic medicinal agents, perfumes, and other coal-tar products. If we examine in detail the statistics of this latter branch, we find that the six largest German manufacturers alone employ more than 18,000 workpeople, 500 chemists, 350 engineers and technologists, and 1360 business men, managers, travellers, clerks, &c. In England, the birthplace and cradle of this industry, there are certainly not more than 30 or 40 chemists and 1000 workpeople employed upon it, and whilst our imports of colouring-matters have slowly increased, our exports to the world of these products, which, fifteen years ago, amounted to about one-fourth of those of Germany, do not now amount to a tenth part. Even in the home market we are only able to supply about ten per cent. of the total quantity of dye-stuffs our textile industries require. In the manufacture of synthetic medicinal agents, artificial perfumes, sweetening materials, photographic developers, &c., which are all outgrowths of the coal-tar colour industry, the matter is even worse, for these manufactures are almost non-existent in this country. Even in the "heavy chemical" trade, which has always been regarded as one of our staple industries, we find ourselves seriously assailed, and most of the important developments of recent years have taken place upon the Continent. We further stand in imminent danger of losing nearly three millions annually by the destruction of our Indian indigo industry in competition with the synthetically prepared indigo of Germany, because the study of organic chemistry has been so much neglected in this country that we have neither attempted to improve (until quite recently) the crude and wasteful methods of obtaining the natural indigo, nor devoted ourselves to discovering methods for its artificial production. Is it conceivable that an English firm of chemical manufacturers would be willing to devote, as the Badische Company have done, nearly a million pounds to experimental plant, and scientific investigations extending over twenty years, in an enterprise of this character?

If, again, we turn to the engineering industries, in which a pre-eminence may fairly be considered our birthright, we meet with a somewhat similar state of affairs. In electrical engineering it is universally recognised that we must now concede the palm to America. Also in tool-making machinery, printing machinery, type-writers, &c., the American manufacturers are able to turn out better and cheaper work than our own. In machinery for chemical processes Germany has established a speciality, whilst in the building of motor-cars—a very large and profitable industry directly developed out of the cycle industry—France by her superior workmanship has been able to obtain a monopoly. We are also outstripped by France in all those industries in which the native artistic taste of the workman plays an important part.

Although it could not, of course, be expected that we should excel in every branch of manufacture, can we consider, with such facts as these before us, that our leaders of industry show the requisite adaptability to modern conditions to which Mr. Balfour refers? or, in other words, are they sufficiently alive to the importance of applying science to industry in every branch of manufacture? Further, are we justified in saying "that there is no lack of well-trained and skilled persons in all branches of manufacture"? Are our technical schools, as Mr. Balfour appears to believe, turning out the men who will reinstate our lost or declining industries? Much as we may appreciate the excellent work which these institutions are doing for the general education of the masses, we are forced to the sorrowful conclusion that this is not so, and that so far as higher scientific education is concerned the results are far out of proportion to the enormous sums which have been devoted to their establishment. The fault for this in no way lies with the technical schools themselves, but with the want of system and incompleteness of our national education. In place of putting a coping-stone of technical knowledge upon an already sound and thorough education, these institutions are more often called upon to cram the elements of a science, or, worse, the details of its industrial application, within a minimum of time into the minds of school-boys or lads engaged in technical pursuits, who, through absence of a satisfactory educational foundation, are quite unfitted for their reception. The result too often is the entire extinction of any natural originality which the lad might have possessed, and the conversion of his mind into a machine for the unthinking performance of routine operations. How is it possible, for instance, that a chemist who, after a very insufficient general education, has acquired his knowledge of the science by a two or three years' course of study at a technical school, should equal in capacity his German colleague, who, upon the basis of a sound school education, has received a five years' training at a German University or Polytechnicum, where he has not only acquired a thorough grasp of his own and cognate sciences, but by carrying out investigations has been stimulated in originality and encouraged to seek new knowledge for himself? Except in the rare instances where native genius is bound to come to the fore, the former can have no possible chance in competition with the latter. It is even a matter of but little moment whether the education of the German has embraced any technical instruction, as with the sound knowledge he possesses of the principles of his science he will soon learn in actual practice their technical applications, and when learnt can usually carry them much further. That nearly all the best positions of the chemical profession in this country are at present filled by German chemists, or by English chemists educated in Germany, is the best proof of the inferiority of our educational methods.

What we undoubtedly require is what Mr. Balfour satirically calls "a manipulation of our methods of education." We require a "system" in the educational fabric of the country, which, together with a better appreciation of the value of science in every industry, would do much to enable our technical schools to fulfil their proper function and to carry out the work which the country expects of them. That such a reform of our educational methods may be long in coming we may, however, well believe, when we hear a distinguished statesman and leader of philosophical thought fail so entirely to appreciate the needs of the case. ARTHUR G. GREEN.

NOTES.

MESSAGES from Newfoundland announce that Mr. Marconi has succeeded in signalling from England to America by wireless telegraph. Detailed information is not yet available, but it is said that the signals which were received at St. John's, three on Thursday and one on Friday last, though faint were unmistakable, and that Mr. Marconi intends to come immediately to England to increase the power of his transmitters at Poldhu, Cornwall, in order to establish more satisfactory communication across the Atlantic. According to later information the Anglo-American Telegraph Company have given Mr. Marconi notice to remove his instruments from the Colony, as they possess a fifty years' telegraphic monopoly, of which there are still two years to run. This will involve the removal of his experimental station to Nova Scotia or to some other convenient place on the American coast line, and may, perhaps, somewhat delay further experiments. It is to be hoped, however, that we shall before long see a further development of Mr. Marconi's remarkable achievement, upon which if confirmed by subsequent results he cannot be too warmly congratulated. It is interesting to compare the possible rapid development of wireless telegraphy in Mr. Marconi's hands with that of the ordinary telegraph. The first Atlantic cable was not laid until five-and-twenty years after the invention of the telegraph by Gauss and Weber. The earliest proposal to use Hertz waves for signalling was made in 1891, and Mr. Marconi began his experiments four or five years later; at that time he was able to signal two or three miles, and now, after five years' work, he claims to have succeeded in increasing this distance a thousandfold.

GEOLOGISTS and geographers will be glad to learn that they may soon expect the publication of a new map of Iceland on which Mr. Thoroddsen, whose labours in his native island are so well known, has been engaged for twenty years. It is on a scale of 1/600,000, or about twenty English miles to the inch, and thus affords at a glance an excellent picture of the general physical structure and geological characters of the country. But it is also replete with details which are expressed in symbols that take up little space and are readily intelligible. The map, of which we have seen a proof copy, is excellently engraved and printed in colours at Copenhagen, and will be issued under the auspices of the Carlsberg Fund. The title and table of signs and colours are in English.

CONVINCED that increased knowledge of the methods of education on the Continent and in America, with special regard to their bearing on questions of commerce and industry, is required in England, Mr. Alfred Mosely, C.M.G., has offered to defray the whole expense of a commission of inquiry, which would visit parts of the Continent and of America to study the question. At a meeting held on Monday, under the presidency of Lord Reay, Chairman of the London School Board, to confer with Mr. Mosely, it was decided that the inquiry should take place in the autumn of 1902. It is understood that the promoters of the inquiry will endeavour to secure the co-operation of a number of public men representing various types of educational authorities and also the interests of industry and commerce.

THE full text of President Roosevelt's message to the U.S. Senate and House of Representatives has now been received, and we are glad to notice that it contains the following references to the valuable assistance given by the Smithsonian Institution to scientific progress:—"The advancement of the highest interests of national science and learning and the custody of objects of art and of the valuable results of scientific expeditions conducted by the United States have been committed to the Smithsonian Institution. In furtherance of its declared purpose —for the 'increase and diffusion of knowledge among men'—the Congress has from time to time given it other important functions. Such trusts have been executed by the Institution with notable fidelity. There should be no halt in the work of the Institution, in accordance with the plans which its secretary has presented, for the preservation of the vanishing races of great North American animals in the National Zoological Park. The urgent needs of the National Museum are recommended to the favourable consideration of the Congress."

THE Imperial Leopold Caroline Academy of Science at Halle will celebrate the one hundred and fiftieth anniversary of its foundation on January 1, 1902.

THE first meeting of the Royal Geographical Society in the new year will be held on the afternoon of January 8, when Dr. Vaughan Cornish will give a lecture on "Waves," adapted to young people. At the ordinary meeting on January 13 Dr. Logan Jack will give an account of his recent expedition from Shanghai to Bhamo, and on January 27 Mr. Stanley Gardiner will lecture on the Maldive Islands.

THE council of the Institution of Mining and Metallurgy announce that a gold medal and premium of the value of fifty guineas, presented by the Consolidated Gold Fields of South Africa, Limited, will be awarded annually to the author of the paper of highest merit contributed to the *Transactions* by any member, associate, or student of the Institution, during the preceding session, upon the mining, treatment, or reduction of gold ores. The first award will be made in June, 1902, and succeeding awards in June in each year.

AN exhibition of burners and appliances connected with the use of gas for illumination and other purposes was opened at the Crystal Palace on Saturday. A development of the Welsbach incandescent light is the inverted burner, on which the cone is fixed in a downward position. It consists of a Bunsen burner fitted with a regulator for the supply of gas and attached to a cone of white china, which acts both as a radiator and as a reflector. Hitherto the difficulty has been to get the Bunsen burner to burn downwards on account of its liability to strike back. This difficulty the manufacturers of the burner claim to have overcome. The construction of the burner, with the globe fixed, closely resembles in appearance the hanging globe of the electric light, and, as there is nothing below the light, no shadow is thrown. A new invention in street lamps is exhibited. This is a high-pressure lamp for burning ordinary gas by the method of a self-intensifying action of combustion, and is said to produce a light of from 300 to 500 candle-power from one burner. There are two stands in the show which exhibit the acetylene light. These are interesting on account of the use which is now being made of that gas, not only for motor-car lights, but also for the illumination of omnibuses in London.

AN exhibition of electrical appliances was opened at the Royal Aquarium on Monday. The exhibits include many ingenious electrical instruments and accessories, such as switchboards, electrical heating and cooking devices, generators, accumulators, Röntgen-ray outfits, lamps, electric clocks, anemometers and electric meters. Mr. W. Langdon, the president of the Institution of Electrical Engineers, who was to have performed the opening ceremony, was unable to be present, owing to his work in connection with the interruption of the telegraphs by the recent gale, but he sent a statement, in the course of which he said that exhibitions were performing good educational work, because they gave the manufacturer an opportunity of bringing his achievements before the public and those interested in their use, and enabled the visitor to obtain a more complete knowledge of the use of what was to be seen. If

England was to compete with other nations in the markets of the world, it was necessary that we should not only foster all our resources, but should also endeavour to see that our merchants and manufacturers were placed in as favourable a position to do so as were those of other nations. President Roosevelt had shown how fully he appreciated the fact that the supremacy of a nation, or, rather, its position in national life, would in future depend upon its commercial success. It would be a great advantage to the producer if he could be placed in possession of information relating to the progress of other lands. This had been recognised by the President of the United States, and they could not help hoping that our own Government would have no hesitation in following his example and promptly establishing a Ministry of Commerce and Manufacture to watch over those all-important branches of our national life.

THE Göttingen Academy of Sciences has decided to establish and maintain at its own expense, during the period of the special international magnetic work, a magnetic observatory near Apia, in the Samoan Islands. The observatory, says *Science*, will be equipped for observations in terrestrial magnetism, atmospheric electricity, meteorology and seismology. This observatory will be nearly magnetically south of the Honolulu observatory, and about the same distance south of the magnetic equator as the latter is north of it. The two observatories will likewise use practically the same instruments and methods, so that interesting and valuable contributions may be expected from them. Mr. A. Nippoldt, of the Potsdam Observatory, will be in charge of the Samoan Observatory.

MR. H. N. RIDLEY, Director of the Botanic Gardens, Singapore, delivered a lecture at the Imperial Institute on Monday entitled "The Economic Resources of the Straits Settlements and the Malay Peninsula." He remarked that the forests, which originally covered the whole peninsula, contain many valuable products, such as timbers, wood-oil, benzoin, gutta-percha and rattans. Owing to the felling of trees by the Malays, gutta-percha, so indispensable for electric work, has been nearly exterminated. Fortunately, however, the product can now be extracted from the leaves and twigs without injury to the trees, which are being planted by the Government. A very large area of the Federated States is under coffee, but on account of the present glut of the market and the consequent low prices, most of the planters are adding Para-rubber to their estates—a tree which thrives marvellously well and produces a very satisfactory amount of rubber of the first quality. India-rubber from the *Ficus elastica* also promises well, but although it is being planted, its product is less highly valued. Accounts were given of the cultivation and preparation of sago—one acre of the sago palm gives as much nourishment as 163 acres of wheat—tapioca, gambir, mangrove-cutch, pepper, nutmegs, cloves, indigo and pineapples. The greater part of the preserved pines of commerce come from Singapore, where the price of the fruit varies from a farthing to a penny each, and the lecturer remembered a time when they had been as cheap as sixteen a penny. The mineral resources of the colony include gold and tin, the latter being found in great abundance.

DURING the past week this country has been visited by disastrous storms, which have caused more interruption to railway and telegraphic communication than has occurred for many years—although in few cases only has the force of a strong gale been reached; the principal damage appears to have been due to the amount and weight of the snowfall. The daily weather reports published by the Meteorological Office show that on the morning of Wednesday, the 11th inst., the barometer was rising generally and that there were no signs of any material change in the weather beyond the fact tha shallow cyclonic areas of a "secondary" character were apparently moving southwards over the northern districts and were likely to occasion snow showers in most parts of the kingdom. But the chart for the next morning showed that a deep cyclonic disturbance had reached our south-west coasts from the Atlantic and was moving in an easterly direction. By Friday morning (13th) communications with many of the northern and north-western stations were completely interrupted. The progress of the storm was rather slow, and the unusual course taken, to the south instead of the north of our islands, brought cold easterly and northerly winds and very heavy snowfall in the north and rainfall in the south. The fall measured at Yarmouth for the twenty-four hours ending 8 a.m. on Friday amounted to two and a half inches (or about the average amount for the month). The loss at sea has not been great, owing, presumably, to timely notice issued to the eastern districts.

SIR CHRISTOPHER FURNESS, M.P., who has recently returned from a business journey through Canada, appears to have been very considerably impressed with the enormous strides that are being made in the development of water-power for manufacturing purposes in that country. On Lake Superior, which is 400 miles long and 160 miles wide, the Lake Superior Power Company, about five or six years ago, commenced operations by constructing a canal from the lake of sufficient capacity to work turbines of 20,000 h.p. This power is used for making pulp for paper from spruce fir, and an area of 8,000,000 acres of forest has been obtained for supplying the wood by grant from the Dominion Government and by purchase. The Algona Iron and Steel Works have also been established; besides the nickel ore which is being worked, a large find of iron, said to be practically limitless, has been located. Large Bessemer steel works for the manufacture of steel rails, capable of turning out 1000 tons of steel rails a day, are expected to be in operation at the beginning of the new year. In these works electricity has been almost entirely adopted for applying the power to the machinery. Further works for developing 40,000 h.p. are in progress and expected to be completed in about a year and a half.

THE equations of rational dynamics required for the solution of physical problems involve only one independent variable, namely the time. Dr. Leo Königsberger, of Heidelberg, has communicated to the Berlin *Sitzungsberichte* a paper dealing with the extension of the Lagrangian equations to systems involving any number of independent variables, in which the kinetic potential is of the most general possible form. In the present paper Dr. Königsberger treats in detail the case of two independent variables, where the kinetic potential involves only differential coefficients of the first order. The author thus formulates a dynamics of two-dimensional, or n-dimensional, *time*, analogous to the geometry of n-dimensional space. Among the most interesting results are those dealing with the conditions under which the principle of conservation of energy holds for two or more independent variables. In the case of two variables it appears that a certain condition must be satisfied in order that an infinite number of integrals of the Lagrangian equations of motion may exist which satisfy the principle of energy, but it is no longer the case that all integrals satisfy the principle in question. A special case is that in which there is only one *dependent* variable; here the equation of energy is always an integral of the equations of motion.

GEOLOGY and meteorology formed the subject of a brief article in NATURE for November 14. Since then an important essay has been issued on the distribution of vertebrate animals in India, Ceylon, and Burma, by Dr. W. T. Blanford (*Phil. Trans.* 1901), who finds that certain peculiarities in the Indian

fauna may have been due to the Glacial epoch. Ancient terminal moraines occur at an elevation of about 7000 feet in Sikhim, whereas no glacier at the present day is known to descend much below 14,000 feet. The author's observations, moreover, lead him to conclude that the Glacial epoch affected the whole world, and that it was not a partial phenomenon induced by special conditions, such as local elevation.

MR. GEORGE ABBOTT, of Tunbridge Wells, has printed a classified list of the "Cellular" Magnesian Limestone Concretions found in the Permian formation of Sunderland. These concretions are grouped as pseudo-organic or discoid, coralloid, and honeycomb, and are considered by Mr. Abbott to have originated in a different way from the botryoidal masses. He illustrates four stages in each group, remarking that the structures have been produced by the action of a "molecular directive force." As a contribution to the study of "concretionary action" the diagrams should prove useful, but some particulars are desirable with regard to the conditions under which the different groups occur.

IN a letter to the *Centralblatt für Mineralogie* (1901, No. 21, p. 641) Dr. Berwerth, of Vienna, discusses the structure of chondritic meteorites. It will be remembered that according to one view the structure is that of a tuff and the stone is the product of a celestial volcano; according to another view, the structure, though fragmental, is not that of a tuff, but the result of the sudden cooling of a molten mass; according to a third view the chondritic structure is that of a metamorphic rock and may be really of a terrestrial origin, having possibly resulted from the enormous pressure on the stone during its passage through the earth's atmosphere. After a minute petrographical study of the Zavid meteorite, Dr. Berwerth infers that the structure of a chondritic stone is that of a metamorphosed volcanic tuff, and that the metamorphosis has been due, not to great pressure, but to a partial remelting of the material, through exposure of the stone to great heat, followed by quick cooling. The author points out that there may have been a sudden development of heat while the tuff was *in situ*, for instance, through the birth of a new and neighbouring star, or, again, that the stone may have passed through the upper region of a sun's atmosphere during part of its celestial journey.

AMONG a number of papers in the recent issue of the *Proceedings* of the Philadelphia Academy, attention may be directed to one by Mr. H. A. Pilsbry on the Clausilias of the Liu-Kiu (Loo Choo) Islands. A large number of these land-shells are recorded, many of which are new; for one group a new subgeneric term is proposed. A second paper, by A. M. Fielde, describes in detail the life-history of the ant known as *Stenamma fulvum*. The observations were made, for the most part, on colonies kept in portable nests, of which a description is given in No. 2 of the second volume of the *Biological Bulletin*.

THE first annual general report has been published (1900–1901) of the newly formed Department of Agriculture and Technical Instruction for Ireland, wherein the scope and constitution of that body are defined. The Dublin Science and Art Museum now comes under the cognisance of the Department, and the report of the director is included in the volume before us. It is satisfactory to learn that the Museum is making steady progress in all its sections. Among several interesting additions to the zoological collections during the year, "by far the most important was Ussher's collection of Irish birds' eggs, contained among which are many which have now become rare and practically unobtainable. For the purpose of showing the wide range of variation in clutches such as those of the peregrine falcon, the guillemot and others, Mr. Ussher's collection is unequalled and invaluable." The director adds that his permanent staff is not sufficiently large to allow him to make all the improvements in the arrangement of the Museum he thinks desirable.

A NEW illustrated catalogue of apparatus for laboratory experiments and lecture demonstrations in frictional and voltaic electricity has been published by Messrs. C. E. Müller, Orme and Co. It is evident from the catalogue that scientific apparatus can now be obtained at a much lower price than formerly.

A WORK on "British Vegetable Galls, an Introduction to their Study, Collection, Mounting, Classification, &c.," by Mr. Edward T. Connold, will be published immediately by Messrs. Hutchinson and Co. The volume will contain numerous illustrations reproduced from photographs of living specimens of vegetable galls.

THE *Electrical Review* devotes practically the whole of its last week's issue (December 13) to electric traction work. The number contains articles by such well-known traction experts as Messrs. Philip Dauson and F. J. Sprague, and also many excellent descriptions and illustrations of machinery and appliances used in traction work, which make it of great value to those engaged or interested in this branch of engineering.

THE first part of a work on "The Fauna and Geography of the Maldive and Laccadive Archipelagoes," by Mr. J. Stanley Gardiner, was published a few weeks ago by the Cambridge University Press. Mr. Gardiner left England in 1899 as Balfour Student of the University of Cambridge, with a commission to explore and investigate the coral reefs of the Laccadives, Maldives and Ceylon. The results of the expedition will be described in the work now in course of publication. The second part of vol. i. will be published in April next, and when the work has been completed it will be reviewed.

MEMBERS of the British Association are well aware that excellent manuals upon scientific aspects of the places of meeting are prepared under the direction of the Local Committees. In connection with the meeting at Glasgow three volumes of this kind were prepared, and as copies have been sent to us since the conclusion of the meeting we presume they are still available. The subjects are:—"Fauna, Flora and Geology of the Clyde Area," edited by Messrs. G. F. Scott Elliot, Malcolm Laurie and J. Barclay Murdoch; "Local Industries of Glasgow and the West of Scotland," edited by Mr. Angus McClean; and "Handbook of Archæology, Education, Medical and Charitable Institutions," edited by Prof. Magnus Maclean. The volumes are filled with trustworthy information upon matters of scientific and engineering interest, and deserve to be widely known. Though published particularly for the meeting of the British Association, probably copies can still be obtained from Glasgow booksellers, or the acting secretary of the Local Committee, Mr. John S. Samuel, 30 George Square, Glasgow.

THE additions to the Zoological Society's Gardens during the past week include a Lesser White-nosed Monkey (*Cercopithecus petaurista*) from West Africa, presented by Mrs. K. Harris; a Green Monkey (*Cercopithecus callitrichus*) from West Africa, presented by Captain R. J. Vyner; a Rhesus Monkey (*Macacus rhesus*) from India, presented by Miss Rodel; a Marica Gazelle (*Gazella marica*) from Arabia, presented by Mr. F. C. Strick; a Common Otter (*Lutra vulgaris*) from Scotland, presented by Mr. W. Radcliffe Saunders; a Plantain Squirrel (*Sciurus plantani*) from Java, presented by Mrs. Beauchant; two South Island Robins (*Miro albifrons*) from New Zealand, deposited; a Nicobar Pigeon (*Calaenas nicobarica*) from the Indian Archipelago, purchased: five Shaw's Gerbilles (*Gerbillus shawi*), born in the Gardens.

OUR ASTRONOMICAL COLUMN.

AN ASTEROID-ORBIT OF GREAT ECCENTRICITY.—Prof. E. C. Pickering announces that from an examination of a plate taken on August 14, 1901, with the Bruce telescope, Dr. Stewart found an asteroid having the great southern declination, $-62°$. Fourteen photographs were taken up to November 13, furnishing approximate positions for the computation of the orbit. A circular orbit was first calculated, which gave the surprising result that the heliocentric diurnal motion exceeded 2200″, indicating a distance from the sun less than that of any known asteroid. Prof. Newcomb furnishes the following elements :—

Epoch 1901, October 2·627 G.M.T.

$$\left.\begin{array}{l} M = 358°\ 30' \\ \omega = 301\ 19 \\ \Omega = 35\ 48 \\ i = 18\ 38 \end{array}\right\} 1900.0 \qquad \begin{array}{l} \phi = 22°\ 8' \\ \mu = 860'' \\ \log a = 0·4103 \\ \text{Period} = 4·13 \text{ years.} \end{array}$$

The uncertainty of the elements ω and Ω may be about $\pm 1°$. It would thus appear that the ellipticity of this new planet is in considerable excess over that of any previously known asteroid. The only others for which ϕ exceeds 20° are :—

	° ′
Eva (164)	20 19
Istria (183)	20 27

The new asteroid was near perihelion at the time of its discovery, moving rapidly round the sun at a distance of about 1·6. It is rapidly moving north, and will soon be available for observation from northern observatories, as shown by the following approximate ephemeris for Greenwich midnight :—

1901.	R.A. h. m.	Decl. ° ′
Dec. 21·5 ...	23 11·3 ...	− 11 42
Jan. 10·5 ...	23 51·8 ...	− 3 47
,, 30·5 ...	0 31·9 ...	+ 3 26

BRIGHT METEOR OF DECEMBER 16.—An exceedingly brilliant meteor was observed at South Kensington on the evening of Monday, December 16, about 6·45 p.m. Starting from near α Persei, about 60° elevation, it travelled in a northerly direction inclining downwards until, after a path of about 30°, it disappeared beneath the Pole star. The meteor was two or three times brighter than Capella, and appeared of a similar tawny yellow colour, although this might have been mainly due to the slight fog prevailing at the time. The trajectory was practically rectilinear and the movement very slow.

THE INERT CONSTITUENTS OF THE ATMOSPHERE.[1]

THE discovery of an element always awakens interest; for the total number of the known elements does not exceed seventy-five, and all the various forms of matter which exist on this globe are necessarily composed of these elements.

Elements must not be regarded as isolated entities, each self-dependent, having no relations with its compeers; on the contrary, all the elements exhibit certain connections with their neighbours; and there is to be traced an orderly progression from one class of elements, strongly electro-positive in character, metallic in appearance, very inflammable when heated in the air, and at once attacked by water, to another class, highly electro-negative, transparent, unattackable by oxygen, and without perceptible action on water, through a number of connecting links, each of which serves to soften the transition.

These elements have been arranged in series, and it is by considering the method of arrangement that our interest is awakened.

The revival of the hypothesis of the atomic constitution of matter by Dalton and of his attempt to determine the atomic weights of the elements was not long in provoking the guess that perhaps there could be found some connection between the numbers representing the relative atomic weights of kindred elements. But, as is well known, the state of knowledge in Dalton's day was not sufficiently advanced to enable him to attribute to elements their correct relative atomic weights; and it was not until the eminent professor of chemistry in Rome, Cannizzaro, whose jubilee has recently been celebrated, pointed out the bearing on Dalton's numbers of all the facts accumulated up to the year 1856 that the close relationship between the atomic weights and the properties of the elements was suggested by John Newlands. Some years later Lothar Meyer and Dmitri Mendeléef amplified and elaborated the ideas which had first been propounded by Newlands; and the periodicity of the atomic weights and the gradual variation of the properties of the elements and their compounds were established on a firm basis.

The division of the elements into metals and non-metals corresponds broadly with another well-marked division—that into basic and acidic. Generally speaking, it is the oxides of the metallic elements which react with water to form bases, and those of the non-metals which form acids with water. According to modern ideas, bases, by the mere act of solution in water, are supposed to be split up into portions, for which the term ion, invented by Faraday, has been retained; one ion is charged by the process of solution with a positive charge, and that portion is usually a metal; the other portion, which consists of one or more groups of hydrogen and oxygen in combination, termed "hydroxyl"—OH—has a negative charge. A base, indeed, is a compound which splits in this manner. On the other hand, an acid, when dissolved in water, undergoes an analogous split; but in this case the electro-positive ion is always hydrogen, while the electro-negative ion may either be an element such as chlorine, or a group of elements such as exist in nitric acid (NO_3).

The order of the various elements in the electric series has been determined; and not merely determined, but to each has been attached a numerical value. This value is identical with what is termed "chemical affinity"; and it represents the electric potential of the element with reference to an arbitrary starting-point, which does not differ much from that of nickel, an element closely related to iron. Only a few such values have as yet been determined numerically; instances may be chosen from the magnesium group, where the numbers run: Magnesium = + 1·2; Zinc = + 0·5; Cadmium = + 0·19; or from the fluorine column, where the numbers are: Fluorine = − 2·0; Chlorine = − 1·6; Iodine = − 0·4. In each case the potential, positive or negative, is the highest for the element with smallest atomic weight, and decreases with increase of atomic weight, for elements in the same column. The order of some of the elements is: Cs Rb K Na Li Ba Sr Ca Mg Al Mn Zn Cd Fe″ Co Ni Pb H Cu Ag Hg′Pt‴′ Au′″; and for electro-negative ions, S″ O″ I Br Cl F; the first element, cæsium, being the most electro-positive, and the last, fluorine, the most electro-negative.

The order given above corresponds fairly well with the order in the periodic table, passing from left to right. But, as in the table, the atomic weights follow each other continuously round the cylinder or round the spiral, the abrupt change from elements of an extreme electro-negative character, like fluorine to sodium, an element of highly electro-positive character, or from chlorine to potassium, has always appeared remarkable. The old dictum, *Natura nihil fit per saltum*, if not always true (else we should have no elements at all, but a gradual and continuous transition from one kind of matter to another—a condition of affairs hardly possible to realise), has generally some spice of truth in it; and it might have been predicted (and the forecast seems to have been made obscurely by several speculators) that a series of elements should exist which should exhibit no electric polarity whatever. Such elements, too, should form no compounds, and, of course, should display no valency; they should be indifferent, inactive bodies, with no chemical properties.

The discovery of argon in 1894, followed by that of terrestrial helium in 1895, and of neon, krypton and xenon in 1898, has shown the justice of the foregoing remarks. Inasmuch as the methods employed for the isolation of these elements illustrate their properties and confirm the views as to their inertness and lack of electric polarity, I propose to sketch shortly the history of their discovery.

An accurate investigation of the density of atmospheric nitrogen and of nitrogen prepared from its compounds led Lord Rayleigh to inquire into the cause of the density of the nitrogen of the atmosphere exceeding that of "chemical nitrogen" by about one part in two hundred, whereas the accuracy of his experiments was such that it would have excluded an error of one part in five thousand. I need not here allude to the reasons which were at first put forward to account for this anomaly; suffice it to say that they offered no

[1] Abstract of an evening lecture delivered at the meeting of the British Association at Glasgow, September 13, by Prof. W. Ramsay, F.R.S.

explanation; and that we ultimately traced the discrepancy to the presence in "atmospheric nitrogen" of a gas nearly half as dense again as nitrogen.

A convenient form of apparatus for isolating this gas is shown in Fig. 1. The gas, air mixed with oxygen, is confined over mercury in an inverted test-tube, in contact with a few drops of a solution of caustic potash; and by connecting the rings with wires from the secondary coil of an induction apparatus, sparks pass between the platinum terminals in the interior of the test-tube. The volume of the gas rapidly diminishes; and in a few hours the gas is removed to a clean tube, and the excess of oxygen absorbed by burning phosphorus; the inert gases remain behind.

On a larger scale, the apparatus used by Lord Rayleigh, consisting of a balloon of six litres capacity, in the interior of which an electric flame is kept alight by means of a transformer, while a jet of caustic alkali forms a fountain in the interior, gives good results. By its help seven or eight litres of mixed gases can be made to combine per hour.

Such experiments show the inactive nature of the argon group of gases towards an electro-negative element, oxygen.

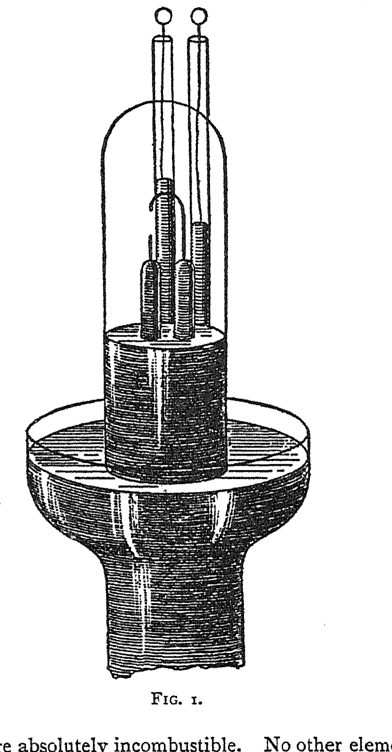

FIG. 1.

The gases are absolutely incombustible. No other elements can withstand such treatment, save platinum and its congeners and gold. But even these metals combine with fluorine or chlorine when heated in a current of one or other gas. Argon, however, is wholly unaffected when electric sparks are passed through its mixture with chlorine or fluorine, the two other most electro-negative elements. To them, too, it shows itself completely indifferent.

A more convenient method of separating the nitrogen from its admixture with argon in atmospheric air is by means of red-hot magnesium. The metal magnesium, which is now made on a considerable scale for photographic and signalling purposes, is a white, silvery metal, which can be planed or turned into shavings. In the early experiments a measured quantity of atmospheric nitrogen dried by passing over suitable drying agents was brought into contact with magnesium turnings, heated to redness in a tube of hard glass It has been found, however, by M. Maquenne that the metal calcium, which, for this purpose is most easily produced by heating together a mixture of magnesium filings and pure dry lime, is a more efficient absorbing agent for nitrogen, for it does not require such a high temperature and can be effected without danger of melting the glass tube. Indeed, the operation is a very easy one and can be carried out with the very simple apparatus shown in Fig. 2. M. Guntz has also found that lithium, an element belonging to the same column in the periodic table as sodium and potassium, is an exceedingly good absorbent for nitrogen, for it tarnishes in nitrogen even at atmospheric temperature owing to the formation of a nitride.

On a large scale the magnesium turnings are contained in iron tubes and the gas-holders are made of copper or of galvanised iron. By this means fifteen litres of argon were separated from about two cubic yards of air.

The inactivity of argon in contact with such highly electro-positive elements as lithium, magnesium and calcium again demonstrates its want of electric polarity. No other elements would have resisted such treatment except those of the argon group. But these are not the only data from which such a conclusion can be drawn, for it was found that no action takes place between argon and hydrogen, phosphorus, sulphur, tellurium, caustic soda, potassium nitrate, sodium peroxide, sodium persulphide, nitro-hydrochloric acid, bromine-water and many other reagents which it would be tedious to mention, all of which are remarkable for their chemical activity. We may therefore take it that the name "argon," which means "inactive," has been happily chosen.

In attempting to form compounds of argon, however, another consideration was not lost sight of; if compounds of argon were capable of existence they ought to exist in nature, and, as in all probability they would be easily decomposed by heat, it ought to be possible to decompose them with evolution of argon, which could be collected and tested. Prof. Miers, in a letter which he wrote me the day after an account of the fruitless attempts to cause argon to combine had been given to the

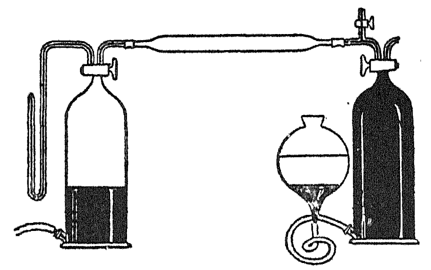

FIG. 2.

Royal Society, drew my attention to experiments by Dr. Hillebrand of the United States Geological Survey, in course of which he obtained a gas, which he believed to be nitrogen, by treating the rare mineral clevite, a substance found in felspathic rocks in the south of Norway, with sulphuric acid. The chief constituents of clevite are oxides of the rare elements uranium and thorium, and of lead. The gas obtained thus, after purification from nitrogen, was examined in a Plücker tube with the spectroscope and exhibited a number of brilliant lines, of which the most remarkable was one in the yellow part of the spectrum, similar in colour to the light given out by the glowing tube. The position of this line, and of others which accompany it, established the identity of this gas, not with argon, as was hoped, but with a supposed constituent of the sun's chromosphere, first observed by M. Janssen of Paris, during an eclipse which was visible in India in 1868. The late Sir Edward Frankland and Sir Norman Lockyer, who studied the spectrum of the chromosphere, gave to the supposititious element, which they regarded as the cause of these lines, the name "helium," a word derived from "ἥλιος," Greek for "the sun." Having been placed on the track, I examined, with the assistance of Dr. Collie and Dr. Travers, no fewer than 51 minerals, while Sir Norman Lockyer examined 46 additional ones, which we had not examined, and in 19 minerals, almost all of them containing uranium, helium was found. Only one gave an argon spectrum, namely malacone. We also sought for argon and helium in meteorites, which all give off gas on heating; but in only one specimen, a meteorite from Augusta County, Virginia, was helium found, in this case accompanied by argon. All natural waters contain argon, for that gas is somewhat soluble in water (4·1 volumes per 100 of water at 15° C.); but some also contain helium, as for instance

the gas from the Bath springs, which Lord Rayleigh found to contain argon mixed with about 8 per cent. of its volume of helium; and helium has also been found in mineral springs at Wildbad, and at Cauterets, in the Pyrenees. It would appear, then, that helium is not such a very rare constituent of our globe; and, indeed, it is probable that it is continually escaping from the earth in small quantities in certain regions.

In 1897, as president of the Chemical Section of the British Association, I chose the title "An Undiscovered Gas" for the address to the Section. The arguments in favour of the existence of such a gas were briefly these: The differences between the atomic weights of consecutive elements in the columns of the periodic table are approximately 16 to 20; thus 16·5 is the difference between the atomic weights of fluorine and chlorine; 16 between those of oxygen and sulphur, and so on. Again, stepping one pace down the scale, we have 19·5 as the difference between chlorine and manganese; 20·3 between sulphur and chromium; 19·8 between silicon and titanium, &c. The total difference between manganese and fluorine is 36; between chromium and oxygen, 36·3; between vanadium and nitrogen, 37·4; and between titanium and carbon, 36·1. This is approximately the difference between the atomic weights of helium and argon, 36. I quote now from that address: "There should, therefore, be an undiscovered element between helium and argon, with an atomic weight 16 units higher than that of helium, and 20 units lower than that of argon, namely 20. And if this unknown element, like helium and argon, should prove to consist of monatomic molecules, then its density should be half its atomic weight, 10. And pushing the analogy still further, it is to be expected that this element should be as indifferent to union with other elements as the two allied elements."

Those who care to read the story of the search for this undiscovered element may find it in the address. Minerals from all parts of the globe, mineral waters from Britain, France and Iceland, meteorites from interstellar space; all these were investigated without result. Helium from various minerals was separated by long and tedious processes of diffusion into a possibly lighter portion, diffusing more rapidly, and a possibly heavier portion diffusing more slowly, but with no positive result. The systematic diffusion of argon, however, gave a faint indication of where to seek for the missing element, for the density of the more rapidly diffusing portion was 19·93, while that of the portion which diffused more slowly was 20·01.

The invention by Dr. Hampson of an apparatus by means of which it is possible to obtain liquid air at small expense and with little trouble placed a new instrument in our hands; and Dr. Travers and I prepared 15 litres of argon from the atmosphere, with the purpose of distilling it fractionally, after liquefaction; for we knew, from the researches of Prof. Olszewski of Cracow, who has done so much to determine the properties of liquefied gases, that argon could be liquefied easily by compressing it into a vessel cooled by help of liquid air. And, moreover, we were in hope that by fractionating the air itself gases of even higher atomic weight than argon might possibly be obtained. Both expectations were realised; on distilling liquid argon the first portions of gas to boil off were found to be lighter than argon, and on allowing liquid air to boil slowly away heavier gases came off at the last. It was easy to recognise these gases by help of the spectroscope, for the light gas, to which we gave the name *neon*, or "the new one," when electrically excited emits a brilliant flame-coloured light; and one of the heavy gases, which we called *krypton*, or "the hidden one," is characterised by two brilliant lines, one in the yellow and one in the green part of the spectrum. The third gas, named *xenon*, or "the stranger," gives out a greenish-blue light and is remarkable for a very complex spectrum, in which blue lines are conspicuous.

Although neon was first obtained by the fractional distillation of argon, it was afterwards found convenient to prepare it direct from air. The torpedo-compressor, which is used for compressing the air before it enters Dr. Hampson's liquefier, was made to take in the air which had escaped liquefaction in the liquefier; the denser portions were thus liquefied, and the lighter portions were liquefied by compressing them into a vessel cooled by the denser fractions, boiling under reduced pressure, and consequently at a specially low temperature. This liquefied portion was again fractionated, and yielded neon; and it was not long before we discovered that helium was also present in the mixture. The presence of helium in atmospheric air had previously been noted by Prof. Kayser of Bonn, and by Prof. Friedländer of Berlin, on submitting the spectrum of argon to a searching examination.

The purification of this mixture of neon and helium from argon, although a lengthy process, was not attended by any special difficulty. It was accomplished by repeated distillation, the lighter portions being always collected separately from the heavier portions, and again distilled by themselves. But after this separation had been accomplished, we found that we were unable by means of liquid air to liquefy the mixture, or indeed any portion of it. We effected a partial separation by diffusion; but it is not possible to separate by this method two gases of which the quantity is limited. Another attempt was made by dissolving the gases in liquid oxygen, on the supposition that neon might prove more soluble than helium; but without satisfactory results. It was evident that a lower temperature than that possible by help of liquid air was necessary.

Prof. Dewar had by that time succeeded in producing liquid hydrogen in quantity, and had indicated the principle, which is identical with that of Dr. Hampson's air-liquefier, although he has not published any detailed account of his apparatus. Dr. Travers undertook to investigate the subject; and after four unsuccessful trials he made a liquefier, with the help of Mr. Holding, the laboratory mechanician, by means of which a hundred cubic centimetres of liquid hydrogen could be easily and cheaply produced. There was then no difficulty in effecting the separation of neon from helium; for, while neon is practically non-volatile, when cooled by liquid hydrogen, remaining in the state of solid or liquid, even that enormously low temperature is not sufficient to convert helium into a liquid. Hence the gaseous helium could be pumped away from the non-gaseous neon, and the latter was obtained in a pure state.

The residues obtained from the evaporation of about thirty litres of liquid air, after being freed from oxygen and nitrogen, were liquefied by help of liquid air, and fractionated from each other. The separation offered no special difficulty, but was long and tedious. It soon appeared that when most of the argon had been removed the residue solidified when cooled; but while it was possible to remove the krypton by pumping, for it goes into gas slowly even at the low temperature of liquid air, very little xenon accompanied it; for at that temperature xenon is hardly at all volatile.

Having finally separated the gases, their densities and other properties were carefully determined; and it was also proved that they are like argon and helium, inasmuch as their molecules consist of single atoms. Neon, as was expected, turned out to be the missing link between helium and argon; the atomic weight of krypton was found to be 81·6, and that of xenon 128. The volumes occupied by equal numbers of molecules of the liquefied gases were determined; and also the boiling-points and melting-points of argon, krypton and xenon. These figures are shown in the following table:—

	Helium.	Neon.	Argon.	Krypton.	Xenon.
Density of gas........	1·98	9·96	19·96	40·78	64·0
Atomic weight.........	3·96	19·92	39·92	81·56	128·0
Density of liquid ...	0·3 (?)	1·0 (?)	1·212	2·155	3·52
Boiling-points.........	—	—	−186·1°C.	−151·7°C.	−109·1°C.
Melting-points	—	—	−187·9°C.	−169·°C.	−140·°C.
Critical temperatures	—	—	−117·4°C.	− 62·5°C.	+ 14·75°C.
Critical pressures ...	—	— (Metres.)	40·20	41·24	43·50
Refractivity of gas...	0·124	0·235	0·968	1·450	2·368

In every case there is seen what is termed periodicity; that is, a gradual alteration with rise of atomic weight, of the densities of the liquids, of the melting-points, of the boiling-points, and of the retardation of light when passed through the gas.

Let us consider, in conclusion, the position of these elements in the periodic table; and it will be sufficient to confine our attention to he groups of elements which form the neighbouring columns. The atomic weights are given in round numbers.

Hydrogen.	Helium.	Lithium.	Beryllium.
1	4	7	9
Fluorine.	Neon.	Sodium.	Magnesium.
19	20	23	24
Chlorine.	Argon.	Potassium.	Calcium.
35·5	40	39	40
Bromine.	Krypton.	Rubidium.	Strontium.
80	82	85	87
Iodine.	Xenon.	Cæsium.	Barium.
127	128	133	137

It is evident that these new elements fall into their natural places between the strongly electro-negative elements of the fluorine group, and the very electro-positive elements of the

lithium group, and that, in consequence of their lack of electric polarity and their inactivity they form, in a certain sense, a connecting-link between the two. It is curious, too, to notice that iodine, xenon, cæsium and barium form the ends of their respective columns. It is, of course, not impossible that other elements may be discovered, possessing similar properties, and yet higher atomic weights than these; but as yet there is no clue to guide us where to search for them.

It is difficult, owing to the impossibility of effecting a complete separation of the inactive elements from each other, to do more than hazard a guess as to their relative amount in air. As they are easily separated from the other constituents of air, there is no doubt as to their total amount; air contains 0·937 parts of argon and its companions by volume in 100 parts. Perhaps the table below may be taken as affording some indication of their relative amounts. Air contains by volume:—

0·937 part of argon per hundred.
One or two parts of neon per hundred thousand.
One or two parts of helium per million.
About one part of krypton per million.
About one part of xenon per twenty million.

It is of course not impossible that xenon may contain an even smaller proportion of a still heavier gas; but it is unlikely. Sea-water sometimes contains a grain of gold per ton; that is one part in 15,180,000; a grain of xenon is contained in about four hundredweights of air.

The problems suggested by the periodic table are by no means solved by the discovery of these aërial gases; but something has been done to throw light upon one obscure corner of the field. The gap between the electro-positive and the electro-negative elements has been bridged.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

PRESIDENT ROOSEVELT has definitely decided not to accept Mr. Carnegie's offer of ten million dollars in Steel Trust bonds for public educational purposes. The provision attached to the offer to the effect that the Government should hold the bonds for a term of years is regarded as being especially objectionable.

THE scheme for the establishment of a University of Liverpool is beginning to take definite shape. A report upon the subject, submitted to the Liverpool University Committee on Monday, stated that the capital invested in land, buildings, equipments and endowments at University College, Liverpool, is not much less than 500,000*l.* To realise the ideal of a modern University, efforts will be made to raise a further capital sum of 330,000*l.* and an additional annual income of 9000*l.* Of the capital sum, 130,000*l.* would be required for additional college land and buildings. The remaining 200,000*l.* would supply an endowment for the professorial chairs and lectureships most urgently needed, especially in modern languages, chemistry and applied science, including electrotechnics. The additional yearly income of 9000*l.* would be needed for maintenance of the various departments, scholarships, equipment of the library, &c. The committee hope that the 330,000*l.* will be provided by gifts of Liverpool citizens and others interested in the highest education; and the additional income will be provided by increased grants from the Treasury, an annual grant from the Liverpool City Council, which, as it helped to create the college, will, it is hoped, give its aid in the establishment and maintenance of a Liverpool University.

THE annual conferences of science teachers arranged by the London Technical Education Board will be held on Thursday, January 9, and Friday, January 10, 1902, at the South-Western Polytechnic, Manresa Road, Chelsea, S.W. There will be four meetings, successively presided over by Mr. T. A. Organ, Sir Henry Roscoe, F.R.S., Principal Rücker, F.R.S., and the Countess of Warwick. The addresses to be delivered are as follows:—"Teaching of Hygiene," Miss Alice Ravenhill; "Mental School Hygiene," Dr. Francis Warner; "Teaching of Natural History," Mr. Frank E. Beddard, F.R.S.; "Value of Natural History Collections for Teaching Purposes," Prof. W. R. Bottomley; "American Systems of Nature Study," Mr. R. Hedger-Wallace; "Nature Study in Schools," Mr. D. Houston; "Technical Education in Rural Secondary Schools," Mr. E. E. Hennesey; "Pioneer Work in Secondary and Technical Education in Rural Districts," Prof. R. Meldola, F.R.S. A collection of home-made apparatus for science teaching in schools will be on view during the days of the conference. Applications for tickets of admission should be made to Dr. Kimmins, Park Lodge, Harrow-on-the-Hill, or to Mr. C. A. Buckmaster, 16, Heathfield Road, Mill Hill Park, W.

THE following resolutions passed by the committee of the Agricultural Education Association were confirmed at a general meeting of members held on Thursday last:—(1) That, if the Board of Agriculture retain their present educational work, it is essential that there shall be complete cooperation between that Board and the Board of Education on all educational matters specially affecting the agricultural classes. (2) That for purposes of agricultural education the country should be divided into districts, and such inspectors appointed as may be necessary. (3) That groups of counties, not yet affiliated to any collegiate centre, should be formed, each group being affiliated to some centre. (4) That, after due inquiry, reports should be issued dealing with the most appropriate forms of agricultural education for each county. (5) That permanent demonstration stations should be organised in each county or group of counties. (6) That official information bearing upon all matters of agricultural interest, whether educational or otherwise, should be distributed to the public free of cost. (7) That to carry out the above objects it is essential that larger funds be placed at the disposal of the Board of Agriculture for educational purposes. (8) That the work of the Board of Agriculture might be facilitated by the appointment of a consultative committee on the analogy of those of the Board of Education and of the Department of Agriculture in Ireland. (9) That copies of the above resolutions be sent to the Presidents of the Boards of Education and of Agriculture.

SIR WILLIAM ABNEY, K.C.B., opened the new science buildings in connection with Watford endowed schools on Thursday last. The new rooms comprise a lecture room, a physics laboratory, museum and balance room, a preparation room and a dark room, which, with the chemical laboratory (28 ft. by 24 ft.), erected in 1892, form a serviceable set of rooms, specially designed for science teaching. The cost of the additions has been about 2000*l.*, and the sum previously expended on science buildings about 1000*l.* In the course of his remarks at the opening ceremony, Sir William Abney said he did not wish any of them to think that whilst they in the secondary branch of the Board of Education encouraged science in every possible way they discouraged the other branches of education which were given at the same time. One of the reasons for starting the schools of science on their present basis was to insure that any boy or girl going through a course of science should at the same time be educated in literary work, which was so necessary in education. Of course there was a great deal of difference between mere instruction and education. The utilitarianism of education was of minor importance; the great thing was education itself. If they could make the instruction that was given useful so much the better. In the old days the only possible means of education was by literary work, classics and so on. There was no science, and therefore they could not say that a boy or girl was to be educated in scientific methods; but he was certain those who founded schools like those at Watford were so alive to the necessity of education that they would be equally alive to the necessity of education in modern methods.

WE are glad to see that the subject of the coordination of the work of the Polytechnic Institutions of London with that of the Colleges was touched upon by Principal Rücker in the course of an address delivered at the South-Western Polytechnic, Chelsea, on Friday last. A place has been found for the Polytechnics in the reconstituted University of London, but their position is not clearly understood, and the direction in which their work may be usefully developed has not been sufficiently described. The Institutions provide opportunities for study and research, and the buildings, with those of other Colleges, help to make the University of London something more than a name. The standard of Polytechnic instruction is perhaps not so high in some cases as might be desired, but it can be raised in the course of time, and the efforts of friends of the University should be directed to this end. It is far better to make the best use of existing educational material than to neglect it. As Principal Rücker remarked, the endeavours that are being made are scattered, and the object of the University is to focus them into one strong effort in order that they may advance as a well-ordered army towards one common end. If that can be

achieved—if the Colleges and Polytechnics can be connected into one great educational machine—something worthy of the metropolis and of the Empire might be accomplished. The aims of the University of London will be, above all, practical. There should be great technical institutions which would prepare men for their work in life, and all who came within the range of the University should acquire something beyond the mere knowledge which enables them to take their parts in life.

THE connection between scientific knowledge and industrial progress was referred to by Mr. Balfour on Thursday last, in distributing the prizes and certificates to students at the Goldsmiths' Institute (see p. 136). He remarked, in the course of his address:—"I am but little qualified to speak by personal investigation or experience of the work of institutions like this; but there is one part of their labours in which I have always felt the deepest sympathy, from a strong sense of its transcendent importance—I mean the teaching which gives a sound and thorough scientific training to those who are engaged in any one of the many pursuits which have a genuine scientific knowledge at their base. I am quite sure that, if we were to gauge the deficiencies of British education as compared, let us say, with German education, they would be found more striking in this branch of education than almost in any other. I am strongly convinced that not only is the necessity of a thorough scientific training great at the present moment, but that the necessity is one which grows with every new discovery. There was a time when in reality theoretical scientific knowledge was wholly divorced from manufactures or any form of practical industry. That state of things has long passed away; and now the alliance between the most abstruse scientific investigations and the general manufacturing output of the country is becoming closer and closer. What was yesterday the curiosity of the laboratory will to-morrow be manufactured in the gross and exported from this country, or from other countries, to every quarter of the globe. And no mere surface knowledge, no mere acquaintance with the methods in fashion at a particular moment, can possibly replace that knowledge of principle which lies at the very root of all these discoveries, and which must be possessed by those who are to attain the greatest success, either as the guides and leaders of manufacturing industry or as the inventors who are to increase the sum of human happiness and health by the work of their brains." The Lord Chief Justice gave expression to similar views in an address delivered at the Rutlish Science School, Merton, on Monday. He remarked that there was not the smallest doubt that what was required in these days—not only in Great Britain, but throughout the British dominions—was a more accurate scientific teaching, a more practical scientific teaching. We were, at the present time, suffering from the fact that those in charge, not only of our commercial supremacy, but of our education, up to some ten or fifteen years ago, had not realised that other countries had discovered that the root of all successful commercial enterprise must be scientific knowledge and investigation.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, November 21.—"Observations on the Physiology of the Cerebral Cortex of some of the Higher Apes." (Preliminary communication.) By A. S. F. Grünbaum, M.A., M.D. Cantab., M.R.C.P., and Prof. C. S. Sherrington, M.A., M.D., F.R.S.

Our experiments have been carried out on individuals representing the four species *Pithecus satyrus* (Orang), *Troglodytes gorilla* (Gorilla), *Troglodytes niger* (Chimpanzee), and *Troglodytes calvus* (Chimpanzee). The specimens so far have included ten adult individuals.

I. *Method employed.*

The method of excitation employed for the cortex has been unipolar faradisation, in the manner previously adopted by one of us (Sherrington, Roy. Soc. *Proc.*, vol. lii., 1893) in examining the cortex cerebri for ocular reactions. This method allows of finer localisation than that possible with the double-point electrodes ordinarily used.

II. "*Motor*" (*so-called*) *Area.*

This area we find to include continuously the whole length of the precentral convolution. It also enters into the whole length of the *sulcus centralis*, with the usual exception of its extreme lower tip and its extreme upper tip.

In all the animals examined, we have found the "motor" area not to at any point extend behind *sulcus centralis.*

On the mesial surface of the hemisphere the "motor" area has extended less far down than was expected. It has not extended to the calloso-marginal fissure. Certain areas near that fissure have yielded us movements, *e.g.* of shoulder, body, wrist and fingers; but we hesitate, for reasons to be given in a fuller communication, to class those with those of the "motor" area proper.

We have found the precentral convolution excitable over its free width, and continuously round, into and to the bottom of the *sulcus centralis.* The "motor" area extends also into the depth of other fissures besides the Rolandic, as can be described in a fuller communication than the present. The hidden part of the excitable area probably equals, perhaps exceeds in extent, that contributing to the free surface of the hemisphere. We have in some individuals found the deeper part of the posterior wall of the *sulcus centralis* to contribute to the "motor" area.

In the "motor" area we have found localised, besides very numerous other actions, certain movements of the ear, nostril, palate, movements of sucking, of mastication, of the vocal cords, of the chest wall, of the abdominal wall, of the pelvic floor, of the anal orifice and of the vaginal orifice.

We find the arrangement of the representation of various regions of the musculature follow the segmental sequence of the

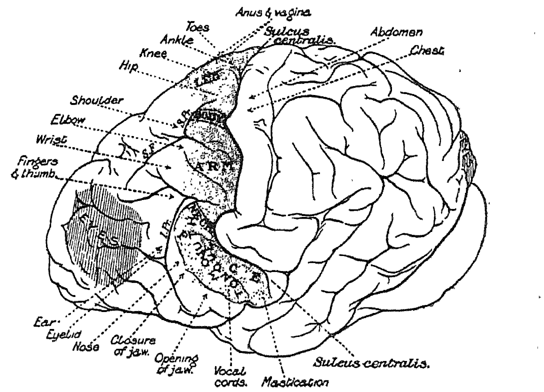

FIG. 1.—Brain of a Chimpanzee (*Troglodytes niger*). The extent of the "motor" area on the free surface of the hemisphere is indicated by the black stippling, which extends back to the *sulcus centralis.* There exists much overlapping of the areas and of their subdivisions which the diagram does not attempt to indicate. S.F. = superior frontal sulcus. S.Pr. = superior precentral sulcus. I.Pr. = inferior precentral sulcus.

cranio-spinal nerve-series to a very remarkable extent. The accompanying figure indicates better than can a verbal description the degree of adherence to this sequence.

We do not find that for the anthropoid brain the exciting current for the "motor" cortex requires to be extremely strong. "Epilepsy" is easily evoked from the cortex of the anthropoids.

Our experiments show that the *sulci* in the region of cortex dealt with can in no sense be considered to signify physiological boundaries. Further, the variation of the *sulci* in these higher brains is so great from individual to individual that, as our observations show, they prove but precarious, even fallacious, landmarks to the details of the true topography of the cortex.

Extirpation of the hand area by itself has been followed by severe paresis of the hand, the hand being for a few days practically useless and seemingly "powerless." In a few weeks use and "power" were remarkably regained in the hand, so that it was once more used for climbing, &c. The animal ultimately not unfrequently fed itself with fruit, making use of that hand alone. Even small ablations in the precentral gyrus have led to severe though quickly diminishing pareses. On the other hand, ablations of even large portions of postcentral gyrus have not given any even transient paresis.

III. *Other Regions of Cortex.*

Our observations indicate that the frontal region, yielding conjugate deviation of the eyeballs, presents such marked

differences of reaction from the "motor" area of the Rolandic region that we hesitate to include it with the so-called "motor" cortex. Spatially it is wholly separate from the Rolandic "motor" area by a field of "inexcitable" cortex. As to the occipital lobe, only from the extreme posterior apex of the lobe and from its actual calcarine region has faradisation yielded any movement (eyes), and then not easily.

The spinal degeneration resulting from ablation in the precentral gyrus of the above-mentioned "hand" area, discovers in the anthropoid cord the human feature of a perfectly large direct ventral (Türcksbündel) as well as crossed pyramidal tract. The relative sizes of these tracts seem about the same as in man.

"The New Biological Test for Blood in Relation to Zoological Classification," by George H. F. Nuttall, M.A., M.D., Ph.D. (Cambridge).

Attention is directed to experiments which prove the value of the biological test for blood in relation to zoological classification. The test is made by means of antisera, which are produced by injections of blood into various animals. If human blood, for example, is injected intraperitoneally into rabbits, the serum of the latter animals, after a course of such treatment, acquires the property of producing a precipitation when it is added to dilutions of human blood. By means of such anti-serum a positive reaction may be obtained with solutions of dried human blood. The anti-serum for human blood also acts on the blood of monkeys. The bloods of eighteen species of monkeys, representing the four families Hapalidæ, Cebidæ, Cercopithecidæ and Simiidæ, all reacted to human anti-serum. The bloods of the first two families (New World apes) gave less reaction than those of the two latter families (Old World apes). Upwards of 200 bloods from other animals gave no such reaction with human anti-serum. In other words, the test has established the existence of a *blood relationship*, as Dr. Nuttall terms it, between the apes and man. It will be remembered that Darwin considered the Old World apes to be more closely related to the Hominidæ than the New World apes, and the degree of reaction obtained with the latter bloods certainly supports this view. Among the bloods which gave no reaction with human anti-serum were those of two species of Lemur.

Similarly, dog anti-serum only produced a reaction in the blood of four other species of Canidæ. The anti-serum for ox and sheep blood only produced reactions in the bloods of other true ruminants (negative with Tragulus and Camelus), the anti-serum for horse blood only reacted wlth the blood of the horse and donkey, &c. These investigations are being prosecuted upon an extended scale.

Hitherto purely morphological characters have served for purposes of classification in the animal kingdom. We now possess a test whereby chemical differences may be determined between the bloods of different animals, as also, to a certain extent, between the bloods of related species, the differences in the latter case being quantitative. Dr. Nuttall believes that it will be possible by means of this test to determine certain relationships which have hitherto been considered obscure. It is certainly a remarkable fact that a fundamental chemical character has persisted in the bloods of all the Anthropoidea, in spite of the widely divergent modes of life and the different character of the food. Limited space prevents a consideration of the chemical nature of the reaction, but we might add that it is at present but imperfectly understood.

Physical Society, December 13.—Prof. S. P. Thompson, president, in the chair.—The following papers were read by the secretary:—On circular filaments or circular magnetic shells equivalent to circular coils, and on the equivalent radius of a coil, by Prof. T. R. Lyle. It is shown that we can represent the magnetic action of any coil by replacing it by one or more filamentary circuits in which currents circulate bearing a simple relation to the actual current in the coil. If the axial and radial dimensions of the coil in question are the same, then the external magnetic action can be represented by that of one filamentary circuit. If the axial breadth is greater than the radial depth we must employ two filaments of equal radii separated by an axial distance, and if the opposite condition holds, two circular filaments of different radii lying in the same plane perpendicular to the axis of figure of the coil. In the case of coils in which the axial and radial dimensions are equal, a modification of Bosscha's method is described which yields the equivalent radii directly as the result of length measurements. If the axial and radial dimensions are not equal, it is shown that the method is still applicable, provided that the ratio of the resistances of the Bosscha comparison be altered in a ratio depending on these dimensions. Apparatus for carrying out the experiment is described and applications to some classical cases are given. It is also pointed out that the correction for finite length of magnet in Bosscha's (or the present) method of comparison is in general far from negligible. The formulæ used are based on the expansion of the potential of a coil for points on its axis, and terms up to the fourth have been included, but the effect of neglecting higher terms is not investigated.—The secretary read a letter from Lord Rayleigh, in which he stated that the length of the magnet used in determining the constant of the current balance used in the determination of the electrochemical equivalent of silver was one-tenth of an inch, and the error due to neglecting this was less than one part in ten thousand.—On air-pressures used in playing brass instruments, by Dr. E. H. Barton and Mr. S. C. Laws. It is well known that in playing upon the "brass" or "wood-wind" instruments of the orchestra the particular note, at any instant desired, is produced by the simultaneous use of the mechanism of the instrument and the corresponding "embouchure" through which air at a suitable pressure is driven by the performer. The object of the paper is to find how the air-pressure required to sound the different notes varies with (1) the pitch of the note, (2) its loudness, (3) the fingering or other manipulation of the instrument, (4) on the instrument itself. Experiments were made with the tenor trombone, the trumpet and the cornet, and the pressures were taken by a water-manometer connected to the performer's mouth by an india-rubber tube terminating in a glass nozzle, which could be held by the side teeth. The following inferences are drawn from the experiments: (1) Other things being equal, the louder the note the greater the pressure. (2) The higher the pitch of the note played on a given instrument the greater the air-pressure used. (3) The curves formed by plotting the logarithms of the frequencies of the notes as abscissæ and the pressures as ordinates are straight lines. (4) The air-pressure required to sound any note with given intensity is approximately proportional to its pitch defined logarithmically. (5) Where alternative positions or fingerings are used for the same note the pressures are practically the same. (6) The pressures for identical notes on trumpet and cornet are almost the same for any given intensity, but very much less than those for the same notes on the trombone. (7) The pressures used for loud low notes may exceed those for soft high notes.—On a new hygrometric method, by Mr. E. B. H. Wade. In this method a thermometer is wetted, not with water, but with sulphuric acid of such a strength that the temperature of the acid bulb is close to that of the dry bulb. The maximum tension of the acid at any temperature is known from Regnault's work, and two or more determinations with this instrument and with a wet and dry bulb hygrometer at the same time enable the constants of both instruments to be determined. If the difference between the acid bulb and the dry bulb is less than 2°, the constant remains fixed over a large range. Experiments show that the readings of the instrument are not affected by ventilation, and since the difference between the temperatures of the bulbs is small, errors in the determination of the constant are unimportant.

Zoological Society, December 3.—Dr. W. T. Blanford, F.R.S., vice-president, in the chair.—Mr. W. E. de Winton exhibited a remarkably large specimen of the grey mullet (*Mugil chelo*), said to have been taken in the North Sea.—A series of papers on the collections made during the "Skeat Expedition" to the Malay Peninsula in 1899–1900 was read. Mr. F. G. Sinclair reported on the Myriapoda, and enumerated the forty species of which specimens had been obtained. Of these, nine were described as new to science. Mr. W. F. Lanchester contributed an account of a part of the Crustacea, viz. the Brachyura, Stomatopoda and Macrura, collected during the expedition, and described six new forms. Mr. F. F. Laidlaw enumerated the snakes, crocodiles and chelonians which had been obtained, and described two new species based on specimens in the collection. An appendix to these papers, drawn up by Mr. W. W. Skeat, contained a list of names of the places visited by the members of the "Skeat Expedition."—Mr. F. E. Beddard, F.R.S., read a paper on the anatomy and systematic position of the painted snipe (*Rhynchaea*), based on an examination of specimens of this bird which had lately died in the Society's menagerie. The author was of opinion that *Rhynchaea* was more nearly allied to the Parridæ than to the

Scolopacinæ. In a second paper Mr. Beddard pointed out the structural differences between the common snipe (*Gallinago coelestis*) and the jack snipe (*G. gallinula*).—A communication from Dr. R. Bowdler Sharpe contained an account of the birds collected by Dr. A. Donaldson Smith during his last expedition to Lake Rudolf and the Nile.—Mr. G. A. Boulenger, F.R.S., described two new fishes under the names *Phractura ansorgii* and *Fundulus gularis*, recently discovered by Dr. W. J. Ansorge in southern Nigeria.

Aëronautical Society, December 3.—Mr. E. P. Frost in the chair.—Papers were read by Sir Hiram Maxim on aërial navigation by bodies heavier than air, by Mr. William Marriott on atmospheric currents, and by Mr. Eric Stuart Bruce on navigable balloons and the scientific aspects of M. Santos Dumont's experiments. Sir Hiram Maxim discussed the work done in navigable balloons by MM. Giffard and Renard. Renard made return journeys, but he never tried a petroleum motor. M. Santos Dumont had done so, had driven his balloon at the greatest pace yet attained, and returned to his starting-point in face of an adverse wind. His motor and balloon had strength and lightness as great as possible, and it did not seem probable they could be improved upon, so that his results seemed carried to the line beyond which no one could go. Turning to the consideration of flying by means of bodies heavier than air, in which, as yet, only a beginning has been made, Sir H. Maxim recapitulated the details of his own machine, relating his preparatory and subsequent experiments, which latter proved that a machine on a large scale could be made to develop a lifting effect greater than its own weight. The petroleum motor would now probably yield the best results. Now, too, there were aluminium alloys strong as wrought iron and light as aluminium, and at the time that he carried out his experiments engineers had nothing so good in their hands. He considered that a flying machine was not only now possible, but practicable.—Mr. W. Marriott, in his paper on atmospheric currents, explained climate and weather as meteorological terms, mentioned the instruments used for meteorological observations, dwelt on pressure records taken on the earth, alluded to the connection between heat and pressure, and by means of a series of charts explained the direction of currents in cyclones and anticyclones. A knowledge of the velocity and direction of winds in the upper air is needed, and he called upon the Aëronautical Society to here help meteorology. Speaking of the valuable kite-observation work of Mr. L. Rotch, up to a height of 8000 feet, Mr. Marriott said that at present a free balloon drifting with the wind can obtain no record of wind pressure or wind velocity; it can only ascertain the direction of the upper currents.—Mr. Eric Stuart Bruce pointed out that for the first time in history M. Santos Dumont had succeeded in steering a balloon from a given point to a given point in a given time. His ingenuity and originality had enabled him to make a real, though small, advance in practice in overcoming the force of the wind; the observations on the Eiffel Tower showed that on the day he won the Deutsch prize the velocity of the wind during his balloon journey was from four to five metres per second. In future navigable balloon competitions, Mr. Bruce thought it should be made a condition that the trials took place when the wind-force was not below a certain value.

Linnean Society, December 5.—Dr. D. H. Scott, F.R.S., vice-president, in the chair.—Dr. W. G. Ridewood exhibited nine specimens of abnormal sacra in the edible frog (*Rana esculenta*) and one in the common frog (*Rana temporaria*).—Dr. J. H. Salter read a paper on protoplasmic connections in the lichens. The author stated, in conclusion, that the observations tended to show that a complete anatomical union exists between the several tissues of the lichen thallus, due to the innumerable connections which may be traced between the ultimate histological units, the segments of the hyphæ. Many physiological problems are simplified, and a new conception is obtained, by our ability to recognise the essential unity of the living matter throughout the organism.—Mr. F. Chapman read a paper on the foraminifera collected round the Funafuti Atoll from shallow and moderately deep water; with notes on new species from the sands of the reef slope. The descriptions were based on material collected by Profs. Sollas and Edgeworth David, and included samples from the beaches down to 200 fathoms and also from the reef slope. They serve as an index to the forms found in the reef-boring. Some idea of the richness of the dredgings may be gathered from the fact that no less than 273 distinct forms are recorded from the dredgings taken between 16 and 200 fathoms. From these samples fourteen new species and varieties have been described.

PARIS.

Academy of Sciences, December 9.—M. Fouqué in the chair.—On the connection of algebraic surfaces, by M. H. Poincaré.—Studies on radium, by M. Berthelot. A detailed study of the action of radium salts upon iodic anhydride. The experiments were carried out at two temperatures, 10° and 100°; blank experiments were carried out, always in the dark, in such a manner as to distinguish between the effects of the phosphorescence produced by the radium and the effects produced by the radium rays in the absence of this phosphorescence. In the case of the iodic acid submitted to the action of the radium tube wrapped round with black paper, that is, protected from the phosphorescence, no reduction took place, whilst in the tube not thus protected iodine was formed. The amounts produced were of the same order of magnitude as the effects observed previously by M. Curie and M. Becquerel.—On the radio-activity of uranium, by M. Henri Becquerel. The observations published by Crookes and by Giesel would tend to show that the activity of uranium may be due to the presence of a small quantity of a very active compound, and that uranium itself is really inactive. This, however, is hardly consistent with the fact that the radio-activity of a commercial uranium salt, whatever may have been its origin, is practically constant. In some earlier work, some uranium salt was fractionated and the radio-active effects concentrated in certain fractions; after the lapse of about eighteen months these fractions were re-examined and were found to have practically the same activity. The lost activity is thus regained spontaneously. A hypothesis is developed which is in accord with most of the observed facts.—The production and maintenance of low temperatures, by M. d'Arsonval. For temperatures down to about −110° the use of solid carbonic acid or acetylene in acetone is recommended, and the necessary precautions given for the maintenance of a steady temperature. For lower temperatures liquid air must be used; it has been found possible to use a bath of carefully rectified petroleum spirit, which remains liquid even at −194°.—Remarks by M. Dehérain on his treatise on agricultural chemistry.—On persistent conjugated systems, by M. A. Demoulin.—On transcendental equations and numbers, by M. Edmond Maillet.—The determination of the observed heights of shooting stars in August, 1901, between the Observatory of Juvisy and the auxiliary station of Antony (Croix-de-Berny), by M. C. Flammarion. The results of the measurements of eight meteors are given, the heights of the first appearance varying between 119 and 15 kilometres, and the heights of the disappearance varying between 68 and 14 kilometres.—A method allowing of the determination of the true velocity of navigable aërostats, by M. H. Deslandres.—A note completing that of November 25 and giving the trace of the trajectory on the ground, with an approximation of about 1/25, of the course of M. Santos Dumont's aërostat on the trial of October 19, by M. J. Armengaud, jun.—The influence of stray currents upon the terrestrial magnetic field, by M. Th. Moureaux. It has been found that in spite of the employment of deadening apparatus the establishment of electric tramways affects, not only the diurnal variation, but also the absolute magnetic elements.—On the auscultation of storms and on the study of the diurnal variation of atmospheric electricity, by M. Th. Tommasina.—On the alloys of aluminium and magnesium, by M. O. Boudouard. The compound Al_4Mg was isolated, and its properties are given. Particulars are also given of the preparation and properties of $AlMg_3$ and AlMg.—On the alloys of strontium with zinc and cadmium, by M. Henri Gautier.—On the state of silicon in cast iron and in ferrosilicons containing a small amount of silicon, by M. P. Lebeau. The compound SiFe cannot exist in the presence of an excess of iron and consequently cannot form a constituent of siliceous cast irons. All the silicon in cast iron would appear to be in the state of the silicide $SiFe_2$.—On a practical means of obtaining trichlorbutyl alcohol, by M. Marcel Guédras. Trichlorbutyl alcohol is prepared by the action of caustic potash upon a mixture of acetone with chloroform. This alcohol is a local anæsthetic, and also possesses antiseptic properties.—On the nutrition of the embryo at the expense of the cotyledons, by M. G. André.—The structure of the lymphatic ganglions of the goose, by MM. L. Vialleton and G. Fleury.—The inoculation of cancer from man to the white rat, by M. Mayet.

—On the existence in cold-blooded animals of a regulating apparatus for heat, by M. J. P. Langlois. Reptiles with impermeable skin have the power of regulating their temperature when it reaches 39° and when the calorific rays strike the head directly.—On the salutary effects of potatoes substituted for bread in diabetics in high doses sufficient to maintain the equivalence of the food ration, by M. A. Mossé. The carbohydrates which may be given to diabetics can be divided into three classes—harmful, indifferent and doubtful—and the potato has been generally placed in this last group. From the experiments here described, the author concludes that the potato is not only permissible, but useful, and may be advantageously substituted for bread.—Organic variations in the hen with respect to its food, by M. F. Houssay.—On the transformations of the germinative vesicle in lizards, by Mlle. Marie Loyez.—Properties of the liberoligneous chains in ferns, by MM. C. E. Bertrand and F. Cornaille.—A contribution to the study of a new disease of the potato produced by the *Bacillus solancola*, by M. G. Delacroix.—The influence of nutritive mineral salts on the production of nodosities in peas, by M. E. Marchal.—Conclusions to be drawn from the study of the series of homogeneous enclosures in a volcanic rock; the series of homogeneous enclosures in the andesites from Mont-Dore, by M. A. Lacroix.—The gases of the blood at different altitudes during a balloon ascent, by MM. J. Tissot and Hallion. The decrease of atmospheric pressure caused by a balloon ascent causes a sensible increase in the power of absorbing oxygen possessed by the hæmoglobin; up to 3500 metres the carbonic acid contained in the blood does not follow the law of solution of gases, on the contrary it varies in the inverse sense. The nitrogen in the blood follows the ordinary laws, the amount diminishing as the pressure is reduced.—Reproductions of the Palæolithic drawings engraved on the walls of the cave of Combarelles, by MM. Capitan and Breuil. The paper is accompanied with reproductions of drawings of a horse, reindeer, mammoth and bison.

NEW SOUTH WALES.

Linnean Society, October 30.—Mr. J. H. Maiden, president, in the chair.—On *Eucalyptus pulverulenta*, Sims, by Mr. J. H. Maiden. The author shows that *E. pulverulenta*, Sims, is conspecific with the "apple or peppermint" of Victoria (one of the trees known as *E. Stuartiana*, F.v.M.) and the "red or black peppermint" of New England (*E. nova-anglica*, Deane and Maiden), both of which he considers to be lanceolar-leaved forms of the species.—On *Eucalyptus Stuartiana*, F.v.M., by J. H. Maiden. The author shows that at least three species of trees have passed under this name, and expresses regret that it is not possible to obliterate the name from the list of species. As this is out of the question, he reiterates the former recommendation of Mr. Deane and himself that its use be confined to the "apple or but but" of Victoria and to the "apple or white peppermint" of New South Wales, the species that probably extends over a greater area than that of any of the other plants included under the name, and the one which was perhaps most frequently named *E. Stuartiana* by Mueller himself.—On *Eucalyptus Gunnii*, Hook. f., by Mr. J. H. Maiden. The author divides the species into the type-form and four varieties, viz., vars. *acervula*, *ovata*, *rubida* and *maculosa*.—The gum-fermentation of sugar-cane juice, by Mr. R. Greig Smith. The viscosity that occasionally develops in cane juice during the manufacture of sugar has been traced to *Bacillus levaniformans*, n. sp., which ferments saccharose producing gum, a mixture of reducing sugars, carbon dioxide and a mixture of acids. Neither mannite nor alcohol is formed. In a culture medium containing 100 grms. saccharose, 1 grm. peptone and salts dissolved in a litre of water, 31 grms. gum and 60 grms. mixed reducing sugars were produced in seven days at 37° C. The gum is formed from saccharose, but not from lactose, dextrose, levulose, maltose, starch or vegetable infusions without saccharose. Peptone increases the gum and acids relatively, and decreases the mixed reducing sugars. The fermentation goes on, though slowly, in weak peptone (·001 per cent.) solutions. The chemical and optical properties of the gum, which is probably the diffluent capsule of the bacillus, show it to be different from inulin, levulan and other previously described gums; it has, therefore, been named levan. Carbon dioxide is produced in good amount, 1·28 grms. being formed from 100 grms. saccharose in five days. The acids are comparatively small in amount, and consist of active and inactive lactic, butyric, acetic, formic and capric acids. These occur in the ratio of about 60 of lactic acid to 1 of the rest. Many races of *Bac. levaniformans* were separated from other sources, and these showed that the organism is related to the potato group of bacilli as a whole and not to any one so-called species.—The chemical properties of bacterial gum levan, by Mr. Thos. Steel. The chemical properties of levan, the new gum produced by the action on sugar of the bacillus described by Mr. R. Greig Smith in the preceding paper, are described. The relationship of levan to other similar known substances is detailed, and it is shown to differ in important respects from inulin, the body which it most nearly resembles generally. The gum found in sugar-cane suffering from the well-known "gumming" disease is quite distinct from levan.

DIARY OF SOCIETIES.

THURSDAY, DECEMBER 19.

LINNEAN SOCIETY, at 8.—On the Brain of Recent and Fossil Lemurs: Dr. G. Elliot Smith.—On the Ostracoda collected round the Funafuti: F. Chapman.—Exhibitions: A Gigantic Argulus from Japan and a Specimen dredged at the Cape: Prof. G. B. Howes, F.R.S.—A New Polyzoon from Tanganyika: J. E. S. Moore.—An Example of White's Thrush (*Turdus varius*), shot near Clavering, Essex: Miller Christy.

CHEMICAL SOCIETY, at 8.—(1) Corydaline. Part VII. The Constitution of Corydaline; (2) The Relation of Corydaline to Berberine. The Oxidation of Berberine with Nitric Acid: J. J. Dobbie and A. Lauder.—The Magnetic Rotation of some Polyhydric Alcohols, Hexoses, and Disaccharoses: W. H. Perkin, F.R.S.—Stereoisomeric Halogen Derivatives of α-benzoylcamphor: H. O. Forster and F. M. G. Micklethwait.—Is Argon an Elementary Substance? G. Martin.

INSTITUTION OF ELECTRICAL ENGINEERS, at 8.—Some Principles underlying the Profitable Sale of Electricity: Arthur Wright.

INSTITUTION OF MINING AND METALLURGY, at 5.—The Titration, Use and Precipitation of Cyanide Solutions containing Copper: Walter H. Virgoe.—Ore in Sight: J. D. Kendall.—Continuous Section System Mine Sampling: M. H. Burnham.

FRIDAY, DECEMBER 20.

INSTITUTION OF CIVIL ENGINEERS, at 8.—Transmission Dynamometers: A. M. Morgan.

INSTITUTION OF MECHANICAL ENGINEERS, at 8.—The Microscopical Examination of the Alloys of Copper and Tin: W. Campbell.

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THURSDAY, DECEMBER 26, 1901.

FIRE PREVENTION.

Publications of the British Fire Prevention Committee, Vols. i to iii., 1898 to 1900. (1, Waterloo Place, S.W.)

THE subject of Fire Prevention is somewhat curiously manifold. The best mode of securing permanent peace is to prepare continually for war, and the most likely way to prevent fire is to have every means of combating it in perfect readiness, so that at the earliest symptom of danger immediate steps can be taken to reduce the temperature. To secure this end knowledge is necessary, and where there is real knowledge there is not much difficulty.

Buildings should be constructed of such materials and in such forms as experience has proved to be necessary for the safety of the contents, whether merchandise or persons, and at the same time the cost must be kept within such reasonable limits that the responsible public or private authority may be justified in rigorously enforcing the regulations laid down for the general good.

To construct a building, as is generally the case, without any regard to its safety from fire, and after its completion to call in an expert to arrange for its protection, is a most expensive and unsatisfactory proceeding.

All the arrangements for its protection should be shown on the original working drawings before a single brick is laid, or even the foundation prepared; and, where this is done with knowledge, no expense whatever, or, at worst, a minimum of expense, will be incurred.

For the protection of merchandise a building can be so divided by fire-proof partitions that the contents of any compartment in it may be burnt out without affecting any other compartment, even when no external aid for extinguishing a fire is available, and this is all that can be done in the way of construction; but there is no difficulty in doing it.

For the protection of life a building should be so arranged that there shall be clear and simple modes of immediate exit within the time necessary for safety in accordance with the nature of the contents.

For instance, in a carpenter's workshop in which no artificial heat is used, and the light is supplied by electricity, a large number of persons can have plenty of time to pass out by ordinary doors in case of emergency, and the same may be said of a warehouse not containing inflammable stock; but it is a very different matter where volatile oils or explosives are stored and manipulated; or where, as in a theatre, large numbers of persons are closely packed in the immediate neighbourhood of scenery or appliances likely to burst forth in flame, and produce volumes of poisonous smoke within a few minutes. It is much more difficult to protect life than property; but it is by no means impossible within reasonable limits. Both subjects may be considered separately.

Of late years much attention has been paid by architects to the materials which they use, and the result has been that new materials have been invented, and improved application of old materials adopted.

The introduction of certain metals, impossible in former years, but now easily available, was a great advance, and the protection of these metals with concrete, plaster, and other substances, has been a still further improvement, but there is something else to which attention should be called.

It may be a little invidious, and in some respects unfair, to speak disparagingly of those who have gone before us, and every allowance must freely be made for them; but to a practical student now observing buildings of one or two generations ago, it certainly does appear that in the great majority of cases there can have been no effort at adaptation.

In all our large centres of commerce and manufacture hundreds of buildings may be found which were originally quite unsuitable to the purposes for which they were used; and, even after expensive alteration and dangerous patching, are by no means either economical or convenient for profitable working at present.

Latterly, however, architects seem to have studied the business of their clients, and on every side we see evidence of thoughtful, practical adaptation for the requirements of every kind of service—private houses, offices, warehouses for all the numerous descriptions of stock, factories for all the various methods of mechanical engineering, placing the fires, the forges, the lathes, the stores and everything else that is necessary in the relative position most suitable for speedy and economical work, and churches and other buildings in which large numbers of persons are assembled. There is still room for improvement in theatres; but there are signs that this is coming or will come in time.

The great hotels and clubs of the present day compared with those of past generations, or even those of twenty years ago, are as palaces to pig-sties, and this improvement is entirely the work of architects who have studied the requirements of their employers.

In the year 1882 the Secretary of State for the Home Department (it is supposed at the special desire of her late Majesty, Queen Victoria) requested from the Metropolitan Board of Works, "A report from the Fire Brigade as to the actual condition of the London theatres in respect of security from fire, stating what additional precautions they think necessary to be taken to prevent loss of life in case of conflagration;" and in the summer of that year, Captain Shaw, the chief officer of the Brigade, made a detailed report on each of the forty-one theatres then existing.

This report is much too long and too full of detail for insertion here; but a few extracts from his "general remarks" at the end may be instructive.

"In dealing with the exits from theatres it is necessary to call attention to the perversity of ingenuity which characterises the arrangements of several houses for getting away. In some cases, where a whole building intervenes between the auditorium and the street, and the space actually existing is more than ample for the escape of an audience, every exertion seems to have been used to make the passages, corridors, landings and stairs as complex and tortuous as possible; and, having done this, then to obstruct them and make them still more inconvenient by pay-boxes, cloak-rooms, barriers, refreshment-counters, single or double steps and partial walls, thus causing nightly confusion and annoyance to the visitors, and adding, moreover, very considerably to their risk in case of panic from fire or any other cause."

"In many cases the first point of actual safety reached by the audience is the street door into the open air, although the removal of a few walls, barriers, pay-boxes and other obstructions, now wrongly placed, would make it 50 or 60 feet nearer the seats, and thus add greatly to the convenience and safety of the visitors."

"In some theatres the attendants seem to spend the greater portion of their time in showing visitors the way."

"I should not recommend a licensing authority to permit the existence of any exit requiring a guide, and I greatly doubt whether any should be permitted which could not be adequately described in half a-dozen words."

"For the safety of an audience it would be most important that the construction of simple separate exits should be encouraged. I should prefer to see them leading into the open air; but the point is not so much where they should lead, as that they should lead by a short route to a place of safety."

"In the event of a panic from smoke or fire or any other cause, the essential conditions of safety for an audience are light and air."

"In the event of a panic, the first steps to be taken by those responsible for the safety of an audience should be to turn on all possible lights, to drop the heat-proof curtain, and to open the smoke-outlet over the stage."

Captain Shaw gives the numbers which could be safely accommodated in the several parts of each theatre, and he makes the total number for the forty-one theatres of that date 53,326.

It is to be regretted that this report cannot be given in full; but it may be hoped that the few selected extracts will supply a general indication of its purport.

Of late years a society has been formed under the title of "The British Fire Prevention Committee," the main object of which is stated to be: "To direct attention to the urgent need for increased protection of life and property from fire by the adoption of preventive measures."

This is an admirable idea, and cannot fail to effect good practical results. The society is altogether private, and has no public authority or sanction whatever, but it is none the worse for this, and it is supported by many persons of influence and practical knowledge, including the late superindenting architect of the London County Council, and will undoubtedly be the means of calling special attention to the paramount importance of *preventive* measures, while it does not in any way ignore the absolute necessity for means of dealing promptly and effectively with catastrophes which have not been prevented.

A thoroughly efficient fire brigade can certainly do much, but, however perfect the supply and distribution of water, or the mechanical appliances and personal intrepidity and skill of the firemen may be, still the safety of any great city, and more particularly of any mercantile city containing a great amount of massed property, must eventually depend on the mode in which its buildings are constructed, and the property within them classified with special reference to risk of fire.

According to a paper read by Sir R. Giffen some years ago at the Royal Statistical Society the wealth of this country was estimated by that distinguished financial authority as 11,500,000,000*l*., or eleven thousand five hundred millions sterling, and Sir John Lubbock, about the same time, stated that a sum of nearly eight thousand millions was passed into the London Clearing House in one year.

Both these amounts would now be considerably increased; indeed, a recent number of the *Saturday Review* gives the annual amount now passing through the London Clearing House at more than eleven thousand millions sterling; but how closely these figures represent the actual value of property liable to be consumed by fire it is difficult to say.

A consideration, however, of the deliberate statements made by such high authorities as these must show beyond doubt that this country contains an amount of material wealth unparalleled in history, and common sense indicates that it is a national duty to preserve it as far as possible from diminution or annihilation.

EMERITUS.

CUNEIFORM DECIPHERMENT.

Assyrian Language. Easy Lessons in the Cuneiform Inscriptions. By L. W. King. Pp. xv + 216. (London: Kegan Paul and Co., Ltd., 1901.) Price 3*s*. 6*d*. net.

MR. KING'S modest little volume on the Assyrian language will, we believe, be welcomed by many who are not Assyriologists, because it contains a brief but lucid exposition of the principles upon which the decipherment of Assyrian is based. It is now many years ago since the first labourers in the stubborn field of Assyriology produced their first fruits, and as two generations of men have grown up since that time the early labours of Rawlinson, Lassen, Hincks, and Norris have become well nigh forgotten. Mr. King's book is, as its title signifies, intended to help beginners in the study of Assyrian to master that difficult language, but it is good to note that he also means the beginner to come behind the scenes and to see, not only the results, but how the results have been arrived at. In these days we are so much accustomed to see translations of cuneiform documents in English, French and German that it is hard to realise that less than fifty years ago the phonetic values of a great number of Assyrian characters were unknown.

The first chapter deals with cuneiform writing, and shows how it came into being and developed. Though so different in appearance now, the cuneiform characters were originally of a pictorial origin, and they appear to have been invented by the Sumerians, a race of people who are generally believed to have come from a Turanian stock. Their earliest forms we now know did not consist of wedges, but of *lines*, and in the characters of *linear* Babylonian the natural objects which they were intended to represent can still be traced. In a table on p. 4 Mr. King gives us four distinct forms of fourteen characters, which date from B.C. 4500, B.C. 2500, B.C. 700, and B.C. 500 respectively; these illustrate clearly the manner in which linear picture forms become groups of wedges, and in a series of notes he shows by comparisons with Egyptian hieroglyphics that the old Sumerian characters, when they were first written down, must have been very similar to those of ancient Egyptian. The Assyrians appear to have been ignorant of this fact, and it is quite clear from their lists of archaic

characters that they could do little more than speculate about it. Mr. King decides, and rightly, that the cuneiform system of writing was produced by the material upon which the Sumerians and Babylonians wrote. On stone it was comparatively easy to cut linear characters, or even signs in which circles and semicircles occurred; but on clay a circle or a crescent could not be made quickly with the three or four-sided stylus, and the outline of a round, or oval, object had to be represented by a series of wedges. That clay became a popular material for writing upon is proved by the fact that its use extended from Elam in the east to Syria in the west, and from Lake Van in the north to the head of the Persian Gulf in the south; the cuneiform system of writing was in use continuously in Mesopotamia for about 4500 years.

Passing next to the decipherment, in an interesting chapter there is set before us the history of the discovery of the Persepolitan inscriptions by early travellers, such as Antonio de Gouvea and Garcia de Sylva y Figueroa, Pietro della Valle and others; the first useful copy of these was made in 1765 at Persepolis by the great Niebuhr. The first successful step towards decipherment was made by Grotefend, but it was not until 1837, when the late Sir Henry Rawlinson took the matter up, that any substantial results were obtained. Mr. King gives us copies of the inscriptions from which Sir Henry recovered the names of Darius, Hystaspes, and Xerxes, and clearly explains his method step by step, and two "cuts" give us an idea of the situation of these important inscriptions on the rock at Elwend and of the famous trilingual inscription at Behistun. The narrative of the manner in which Sir Henry overcame all difficulties is extremely interesting, and the world owes almost as much to his physical as to his mental energy.

Want of space prevents us from doing more than mention the Susian and Babylonian texts at Behistun, and we therefore pass on to note that the third chapter is devoted to a description of the system in which cuneiform characters are employed as syllables, ideographs, and determinatives. It is astonishing that the Assyrians or Babylonians did not reduce their cumbrous syllabary to an alphabet, as did the Egyptians and the Persians. Following this description we have a good selection from the Assyrian syllabary, printed in the cuneiform character, with syllabic and ideographic values, &c. The latter part of Mr. King's work contains a series of interesting extracts from cuneiform texts, with transliteration and translation arranged with them either interlinearly or on the opposite page, and the last few pages of the volume are devoted to a small glossary. For a book of the size no one could expect long dissertations on abstruse points of grammar or history, it being clearly understood that for matters of this kind the advanced student must consult the larger works on Assyriology.

The little volume before us is admirably suited for the purpose for which it is intended, viz., to enable the beginner to lay hold upon the first principles of the Assyrian language, and the frequent use of cuneiform type throughout its pages will help him to become familiar with the difficult character in which the sages of Mesopotamia in all ages seem to have written down their wisdom. The cuneiform type is clear and very legible, and is, if we mistake not, copied from the fount which was specially cast for Rawlinson's "Cuneiform Inscriptions," but was at the last moment abandoned in favour of lithographic copies of texts made first by Mr. Bowler and after his death by Mr. Jankowski.

ELEMENTARY HISTOLOGY AT CAMBRIDGE.

Practical Histology. By J. N. Langley, M.A., Sc.D., F.R.S. Pp. viii + 340. (London: Macmillan and Co., Ltd., 1901.) Price 6*s.*

THIS book is an embodiment of directions for practical work in animal histology, which the author, as the result of twenty years' experience, has been led to regard as best suited to the requirements of the elementary student, with the greater part of those of the histological section of the last edition of the "Practical Physiology and Histology," by Sir M. Foster and himself—one of the best established of the famous red-cover series of didactic manuals for students, which have done so much for the practical side of modern scientific instruction. The body of the book (286 pp.) is divided into thirty-six lessons, of which the first eight are devoted to methods and the use of the microscope and microtome. Those numbering nine to thirty-five are set aside for the tissues and organs, and the thirty-sixth deals very slenderly with the main facts of cell-division. In each of these "lessons" there are first given such accounts of the organs and tissues as are necessary for manipulative purposes, and descriptions of methods of treatment likely to yield constant results in the student's hands. There follows for each lesson, under the heading "Demonstrations," a list of objects to be correlatively studied or examined; and finally (in small type) a series of "Notes," having reference to cognate and alternative objects of interest and to methods supplementary to those described in the body of the lesson, with especial reference to such as require particular skill and attention or are variable and uncertain in their action. *Apropos* of this arrangement (which is but an extension of that adopted for the volumes which preceded the present one) and the "Notes," the author points out, with commendable care, that he has been careful to avoid making manipulation too much of an end in itself; and he thereby introduces a welcome check to the tendency on the part of pure histology to lapse into a mere laborious idleness.

The book is up to date and evenly balanced, and is sure of success equal to that of its predecessors. In his acknowledgments to those who have helped him the author naïvely alludes to the "unending suggestions" for "modifications in procedure," and we have these in evidence in many of the pages of the book.

It may now more than ever be said of animal histology that the history of its progress is that of method, since, on this basis, the far-reaching generalisations of Ramon y Cajal, which but seven years ago threatened to revolutionise our conceptions of the structure and mode of action of the nervous and sensory epitheloid apparatus, are by Apathy and others being challenged. Cajal's methods receive recognition in the present work. While we could hardly expect this for Apathy's until more fully confirmed, we could desire a fuller recognition of the discovery by Dogiel of the double innervation of

Meissner's corpuscle, and of the rapidly accumulated evidence of the same condition in that of the Pacinian, Herbstian, and even the Grandryian type. This discovery, which we owe to Dogiel and his pupils, with Timofeew and Sala, imparts a new character to the tactile body in all its forms; and it marks one of the most welcome and important advances in recent histological work, demanding the attention of even the elementary student. If only it had been made in Cambridge!

OUR BOOK SHELF.

A Catalogue of the Lepidoptera of Ireland. By W. F. De Vismes Kane. With a coloured plate. Pp. xviii + 166. (London: West, Newman and Co., 1901.) Price 10*s*.

THE earliest catalogues of Irish Lepidoptera were published by the Rev. Joseph Greene and the Rev. A. R. Hogan in 1854 and 1855 in the first two volumes of the *Natural History Review*, but were merely tentative, not only being very incomplete, but including many species on the evidence of collections without history, or else taken in localities where they were almost certainly introduced. These authors enumerated 636 species as Irish. The late Edwin Birchall's list, published in the *Entomologists' Monthly Magazine* from 1866 to 1868, was a much more valuable work. Mr. Birchall enumerated 974 species, though several included in the former lists were very properly omitted. The list now before us, which was originally published in the *Entomologist* from 1893 to 1900, is carefully compiled, chiefly from original sources, and brings down the subject to the present time; but the species are not numbered, and no comparison is made, as should have been done, with the number given in Mr. Birchall's catalogue.

Mr. De Vismes Kane's book will be very useful to entomologists visiting Ireland, or to those anxious to study the character of the Irish fauna from a Lepidopterous point of view. This is discussed by the author in his introduction, in which he refers not only to the comparative poverty of the fauna, both as regards number of species and of individuals, even in comparison with England, but states that the climate has been so unfavourable to insects of late years that they have become still scarcer than before, while some species, formerly common in certain localities, have apparently disappeared entirely. On p. xviii. the author alludes to his having assisted Colonel Cooper in 1885, 1886 and 1887 in the attempt to introduce various Continental species into Sligo, experiments which, happily, failed. He adds: "The attempted acclimatisation of such exotics as the above I consider wholly unobjectionable, since if it were successful, none of the species could have been mistaken for natives." Among these "unobjectionable species" was *Porthetria* (or *Liparis*) *dispar*, the gipsy moth, the introduction of which might have been one of the most grievous calamities that has befallen Ireland for many years; and this gives us the opportunity of suggesting that the Government should absolutely prohibit the rearing of any species in the open which are known to be destructive abroad, notwithstanding their being rare or unknown in the British Islands; while a specially heavy penalty should be attached to the introduction of living specimens in any stage or for any purpose of such species as *Liparis dispar*, as in the case of the not more destructive Colorado potato beetle. What would Colonel Cooper have thought if in a few years he had found that the whole of his forests were being stripped of their leaves by the larvæ of *Liparis dispar*, as might easily have been the case had the climate and conditions proved favourable to the insect?

An Atlas of the Medulla and Midbrain. By Florence R. Sabin. Pp. 123; 7 coloured plates, one black plate and 52 figures. (Baltimore, Md., U.S.A.: The Friedenwald Company, 1901.) Price 1·75 dollars.

THIS book consists of a detailed account of a model of the medulla oblongata, pons Varolii and mesencephalon, which was made in the anatomical laboratory of the Johns Hopkins University by a reconstruction in wax of every alternate slice of a series of horizontal sections of the brain-stem of a new-born babe. The sections had been stained by the method of Weigert, so as to differentiate clearly the various nerve tracts, which are so distinct, the one from another, at the time of birth.

In the reconstruction only the important nerve tracts and the compact masses of grey matter have been represented, so that a glance at the model reveals the exact shape and relations of the peculiarly-contorted grey-masses and intertwining fibre-tracts, and enables the student to form an accurate mental picture of the most complicated and difficult region of the brain, such as no other method of study can convey.

Miss Sabin has carried out the arduous and laborious task of building the reconstruction in a manner so careful and patently successful that for the first time an accurate and trustworthy model is provided of a region which so many people have hitherto attempted to represent graphically by less tedious and correspondingly more inaccurate means.

The series of drawings representing the wax reconstruction has been so happily executed by Mr. Max Brödel that the model itself is hardly necessary.

Miss Sabin's description is full and complete and is illustrated by a large number of drawings both of the horizontal sections, from which the model was built up, as well as a "control series" of transverse sections of another brain-stem of the same age.

The view obtained of familiar structures is so novel, and one's attention so riveted in the mental accommodation, that the reader hardly looks for new observations. Nevertheless, the author has not only critically summarised the current literature of the structure of the medulla, pons and midbrain, but has also added to our knowledge of these regions.

The bibliography, which is intended for students, attains the happy mean of being sufficient without being bewildering.

In a work which is so happily conceived and so admirably executed there is little call for criticism. In perusing the work we noticed only one misprint. One of the figures (Fig. 50) has been misplaced; and it would be of considerable advantage to the student if Plate viii. were inverted so that the parts might be placed as they are in the body (and in Plate iii.).

This book and the model which it describes must convince anyone, who has carefully studied the structure of the brain-stem by means of the examination of sections, of the inadequacy of the conception of this complex region which he can acquire by such means; and it will be an invaluable aid for conveying to students an accurate understanding of this important part of the brain, which could not otherwise be acquired even by months of careful study. G. E. S.

Les Variations de Longeur des Glaciers. By Charles Rabot. Pp. 250. (Geneva: Georg and Co., 1900.)

THE study of the variations in the lengths of glaciers is one that has formed the object of investigation of many workers, and as the subject, besides being of considerable interest, is one in which exact information is very difficult to secure, various opinions may be formed as to the lengths of the periods of variations deduced.

What is therefore wanted to render deductions more exact is a great number of observations, spread over a considerable interval of time, and the more the observa-

tions can be made on a uniform plan, the more accurate will be the results obtained.

In February 1897, M. Rabot published the first part of the present work on the variations of the lengths of glaciers in the temperate and Arctic regions, and since that time the subject has been taken up by several other enthusiastic workers, so that now important information has accumulated. Thus Prof. Erich von Drygalski has made a study of the glaciers in Greenland, Prof. E. Richter has worked at the glaciers in Norway, while Mr. Israel Russell has confined his attention to North America.

In the book before us M. Rabot brings together all the data concerning the measures and appearances of the glaciers in the Arctic and temperate regions, giving references in each case to the original source of information. In the last chapter he brings together the conclusions to which he has arrived, but the reader must be referred to the book itself for a full account of them. The main results may, however, be here briefly expressed, and they are as follows :—

Prior to the eighteenth century, glaciers were much less extensive than they are to-day. During the eighteenth century and up to the first years of the nineteenth, an enormous increase, surpassing the amplitude of a single variation, occurred. Glaciers invaded territories which had never been previously occupied. This increase was general and affected all those in the northern hemisphere. During the nineteenth century the variation was indecisive. In some regions a considerable increase followed by a slight diminution in glaciation was noted, while in others the glaciers, after having remained at a maximum up till nearly the end of the century, diminished slightly. In no part was there such a considerable regression observed as that recorded in the Alps during the last fifty years.

With regard to the question of the oscillations of the lengths of glaciers in consequence of the variations of climate, which Prof. Richter has indicated does occur in the case of the Alpine glaciers, M. Rabot suggests that our knowledge is at present too incomplete to settle such a point with certainty.

Before bringing these remarks to a conclusion it may be added that this important work adds much to the advancement of our knowledge of the secular variations of the lengths of glaciers, and M. Rabot is to be congratulated on the important part he has so successfully played in its production.

Experimental Hygiene. By A. T. Simmons, B.Sc., and E. Stenhouse, B.Sc. Pp. viii+322. (London: Macmillan and Co., Ltd., 1901.) Price 2*s.* 6*d.*

IN their preface the authors state that the value of an introduction to the scientific method in the school training of both sexes is now recognised. That is so; but the scope and treatment of this scientific matter is the subject of a considerable amount of controversy at the present time among different authorities. Certainly no more suitable means exist of illustrating physical and chemical laws than by demonstrating their operation in the ordinary every-day occurrences with which the student is familiar.

It is no exaggeration to say that without some scientific knowledge the intelligent appreciation of the principles of hygiene and domestic economy is impossible. The writers of the work are therefore to be congratulated on having undertaken it with so excellent a motive, and one turns with considerable interest to the subject-matter to see how far they may be judged to have attained their object.

By the authors' scheme each subject is dealt with by first describing a few simple experiments and their results, then the physical and chemical principles responsible for those results are explained, and lastly it is pointed out how these principles are applied, or how they serve to explain certain every-day occurrences. At the end of each chapter there is a brief summary of the facts therein dealt with, and a series of exercises are then set out for the student. The book is well balanced throughout in its treatment of a large variety of scientific facts, and the matter is sound and well selected. The sole instance which we have noted in which exception may be taken to the teaching has reference to a simple means of filtering water. On pp. 148–149 the student is advised to clean a flower-pot and plug the hole at the bottom with a piece of sponge, then to place sand, with pebbles or charcoal, into the pot. Such a filter would not be efficient, and the householder would be safer if in his wisdom he preferred to drink the unfiltered water rather than make use of it.

The book concludes with an excellent chapter upon micro-organisms, where, in only nine pages, an account is given of those interesting growths which well meets the requirements of such a work. It is, in short, just sufficient to give the student an intelligent appreciation of what germs are. The book can be confidently recommended. It is of a handy size and well printed and bound.

Dictionary of Philosophy and Psychology. Edited by J. M. Baldwin. Vol. i. Pp. xxiv+644 (A—Laws of Thought). (New York: The Macmillan Co. London: Macmillan and Co., Ltd., 1901.) Price 21*s.* net.

THIS long-promised work will be of the highest value to every worker in fields which are in any way touched by psychological or philosophical thought. The contributors are almost all men of the highest eminence in their subjects, and the general editor has long been known as one of the ablest of the younger American psychologists. Some of the longer articles (*e.g.* "Brain") are really scientific treatises in miniature; where brevity is possible the articles are most laudably brief. A particularly valuable feature of the work is the series of monographs on philosophical terminology (arts. "Greek Terminology," "Hegel's Terminology," "Kant's Terminology"), by Prof. Royce, of Harvard. The outward appearance and the typography of the book reflect the greatest credit on the publishers and the Oxford University Press.

The end of the alphabet is to be reached in vol. ii., and vol. iii. will consist of a series of full bibliographies of the various departments of philosophical and psychological literature. A. E. T.

Die Vogelwelt des Amazonenströmes; Enstanden als Atlas zu dem Werke "Aves do Brazil." Von Dr. Emil A. Goeldi (1894–1900). Part i. (Zurich: Polygraphischen Institut, 1900.)

WE have received from the Polygraphischen Institut of Zurich a copy of the first part of this atlas, which is merely a replica in German of the one noticed in our issue of August 22, 1901, under its Portuguese title of "Album de Aves Amazonicas." In fact, it is only the cover that has been altered, the descriptions of the plates themselves remaining in the original Portuguese. We have nothing to add to the remarks made in the notice referred to, except that the plates are excellent examples of three-colour printing.

The Betteswortk Book. Talks with a Surrey Peasant. By George Bourne. Pp. vi + 325. (London: Lamley and Co., 1901.) Price 5*s.* net.

FROM a scientific point of view there is little of interest in this book, but as a realistic record of the thoughts and experiences of a Surrey labourer, reproducing more or less the dialect of the county, the conversations are certainly worth preserving. There is no attempt at fine

language or refined rhapsodies on rural life and scenes, but in natural vigorous words Bettesworth—that was the name of the labourer—gives his opinion upon sundry persons, places and things he has known. The ethnographer will here and there find descriptions of country customs and remedies which will interest him.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

Relative Velocity in Streams.

IN your review of the report of M. Vallot from his observatory on Mont Blanc (p. 31) you speak of his finding that a stream ceases to increase in speed in a channel of greater incline than 3 in 100 as something unexpected.

For more than twenty years I have contended, in repeated publications, that friction against the bed increasing progressively from the middle to the margin divides every stream longitudinally into two halves, which roll spirally toward each other. This spiral being determined by the friction, its helix rises with the speed, or the increased friction depending on the speed, which in turn depends on the slope of the channel. It follows that beyond a certain speed the stream loses all the momentum gained by its fall in beating with the two outward-moving undercurrents against the channel walls. In this way the stream attains its kinetic equilibrium. If glaciers are plastic or viscous bodies, they, too, must obey the same laws.

Louisville, Kentucky, U.S.A. D. T. SMITH.

Change of Pitch of Certain Sounds with Distance.

IN NATURE of December 12 (p. 129), Mr. F. M. West describes an observation made while walking up and down the platform of a railway station. The pitch of the sound caused by the steam escaping from an engine rose as he retreated from it and fell as he drew near to it.

As I gave the explanation of the same phenomenon in *Les Archives Néerlandaises* (Arch. Néerl. Livre jubilaire, November 1901), I may be permitted to give a summary in these pages.

The pitch will not only rise by retreating from the engine, but also by bringing the ear nearer to the ground. The pitch is due to reflection of the sound from the platform itself, for when a large board is laid down on the ground between the engine and the observer, the pitch will be heard to rise when the board is raised.

It is clear, therefore, that the pitch can be caused by interference of the direct and the reflected sound-waves, a phenomenon wholly similar to Lloyd's experiment with light-waves. As in Lloyd's experiment the elementary colours of the white light are separated in space, so here the different pitches of sound will predominate in different points of space, and a sort of sound-spectrum will be formed.

A mathematical examination enables us to analyse the irregular vibration of a noise during a short time, according to Fourier, into a series of harmonic vibrations. Moreover, it can be proved by calculation that the interference of the direct and the reflected sound-waves must cause at any spot a series of (impure) pitches to be heard. The wave-lengths of these pitches must be 1/1, 1/2, 1/3 . . . of the difference of distance travelled over by both sounds.

An experimental examination, made at the platform of a railway station, has shown me that the pitch of the noise of an engine fully agrees with the theory, so far as the impurity of the pitch permitted an exact experiment to be made.

When the noise of a waterfall or rustling trees is perpendicularly reflected by a wall, Baumgarten has observed the change of pitch in the vicinity of this wall (Müller-Pouillet, "Lehrbuch der Physik," i. p. 732). The above-mentioned result is also applicable in this case. In the neighbourhood of a waterfall I obtained experimental results perfectly agreeing with theory.

D. VAN GULIK.

Apeldoorn, December 15.

CHEMICAL INSTRUCTION AND CHEMICAL INDUSTRIES IN GERMANY.

JUST now, when men of science and educationists are continually directing attention to the superiority of German educational and industrial methods, especially in the domain of chemistry, a report published among the "Miscellaneous Series" of the Foreign Office is most apposite, and should be studied by all who are truly interested in the educational and commercial welfare of the nation.

The object of the report, which is compiled by Dr. Frederick Rose, His Majesty's Consul at Stuttgart, is "to show to what extent the German chemical industries have benefited by the sums expended by the German States on chemical instruction." A perusal of the contents of this highly interesting and instructive report shows us that the German technical high schools or polytechnics differ *in toto* from those of the United Kingdom. They are, in fact, more like our University colleges, *e.g.* Owens College and Mason College (new University of Birmingham). The older Universities in Germany began to study chemical technology about the middle of the seventeenth century. They thus laid the foundation-stone of the present-day industrial chemistry for which the country has become famous. As trade and chemical industries gradually advanced, the Universities were found inadequate to train the greatly increased number of chemists who were required. The polytechnics (now called technical high schools) were consequently founded. These are, without exception, products of the nineteenth century. One must not, however, lose sight of the fact that it is only within the last two generations that the technical high schools have assumed such prominence. They had first to learn what was required of them if they were to exert a really beneficial effect upon the welfare of the country. On p. 8 of the report the following words appear, which we trust some of our technical educationists will take to heart:—

"The study of architecture, engineering and chemistry at the technical high schools left, at the beginning, much to be desired, as the erroneous opinion prevailed that it was not necessary for the students to devote themselves to the study of scientific works, but rather to acquire a certain practical aptitude in superficial manipulation. . . . Later on, however, it was clearly perceived that the scientific foundation laid during the scientific courses at the technical high schools formed the soundest basis for the practical experience to be gained during professional life."

In the British polytechnics the teaching staff have no social status, and the scale of remuneration depends entirely upon the governing body, who have usually great difficulty in making both ends meet. But in the Prussian technical high schools, which are under the direct control of the State, the members of the professional staff possess the rank of full State officials, and the salaries are regulated according to certain fixed limits. Indeed, so deeply is the German Emperor convinced of the importance of technical education that he has caused the directors of the Prussian technical high schools to be admitted to the Prussian Upper House, while a short time ago at the centenary of the Berlin Technical High School he conferred upon the Prussian technical high schools the right to confer a new degree of Doctor of Engineering, thus practically raising the technical schools to the level of the Universities.

Before the students are allowed to pass into the technical high schools they must show that they have obtained a preliminary education of a very high order. Whilst it is no unusual thing in our polytechnics to find students who have absolutely no knowledge of the merest elements of arithmetic and who are quite unable

to enter the results of their experimental work in an intelligible manner, such students could not enter the German technical high schools.

Students of chemistry who enter the technical high schools do not devote the whole of their time to chemistry; they take out a full technological course, including such subjects as trigonometry, higher mathematics, physics, botany, electrotechnics, technical drawing, machine drawing, &c. The above subjects have been taken at random from the syllabus of the Darmstadt Technical High School for 1895. Perhaps, however, the thoroughness of the courses through which the student must pass before obtaining his technological diploma is best shown by a study of the syllabus of the Stuttgart Technical High School.

Subject	Number of hours per week					
	1st year		2nd year		3rd year	
	Summer term	Winter term	Summer term	Winter term	Summer term	Winter term
Mineralogy and geology ...	4	5	—	5	—	—
Zoology	3	3	—	—	—	—
Botany	—	—	3	6	—	—
Physics	4	4	—	—	—	—
Experimental chemistry ...	4	4	—	—	—	—
Theoretical chemistry	—	4	—	—	—	—
Analytical chemistry	2	2	—	—	—	—
Organic chemistry	—	—	5	2	—	—
Technical chemistry	—	—	4	2	—	—
Dye industries	—	—	—	—	3	—
Building construction	5	—	—	—	—	—
Elements of machinery ..	—	—	5	6	—	—
Electro-chemistry	—	—	—	—	—	1
Political economy	—	—	—	—	3	—
Elementary jurisprudence ...	—	—	—	—	3	3
Microscopic laboratory ...	—	—	—	2	—	—
Chemical laboratories	12	12	12	12	24	24
Total	34	34	29	35	33	28

Any extra time at the students' disposal is devoted to practical chemistry, bacteriology, or the chemistry of foods, &c.

The pioneering labours of the German Universities are known to everyone. For pure chemical research they have obtained for themselves a position which places them almost above criticism, and which has made them the envy of the world, insomuch that students flock to them from all countries. In 1897 there were 13,000 students at the Prussian Universities; of these 9 per cent. were foreigners. Each of these students costs the State 31*l.* annually, or about 36,000*l.* In the Prussian high schools during the same year there were 4246 students, of whom 13 per cent. were foreigners, costing the State 14*l.* per head, or nearly 8000*l.* That is to say, in 1897 the Prussian State expended 43,000*l.* on the education of foreigners, many of whom would in all probability enter into trade competition with themselves. Taking the whole of Germany into account it is calculated that no less than 60,000*l.*, or the interest on 2,000,000*l.*, was expended in educating foreigners.

In one respect the German Universities and polytechnics possess an enormous advantage over those of this country—*they are not hampered by want of funds.* The German Government realises the importance of education, hence the Universities and technical high schools are built upon the most modern principles and fitted up in a style which is little short of perfection. It must not, however, be denied that here we also build and fit up polytechnics in a manner which leaves little to be desired, so far as the external structure and paint and varnish are concerned. But it so often happens that all the funds have been swallowed up by bricks and mortar, hence there is no money forthcoming for adequate equipment and maintenance,[1] much less for research. The result is, the teaching staff is miserably inadequate and consequently overworked.

The following table, the numbers in which are taken from the reports from University colleges, issued by the Education Department, gives the income and the Government grant for five of our University colleges for the year ending July 31, 1899:—

	Income.		Government Grant.
	£		£
King's College, London ...	42,369	...	2200
University College, London	35,456	...	3000
Owens College	47,494	...	3500
University College, Liverpool	23,792	...	3000
Mason College, Birmingham	17,864[2]	...	2700[2]

Contrast this with the German Universities and technical high schools; for our Universities and University colleges, as well as our polytechnics, are but too often without sufficient income.

In 1899 the total income of the University of Berlin was 143,555*l.*; of this large sum no less than 83 per cent. was contributed by the State, while 80 per cent. of the income of the University of Bonn (63,037*l.*) was obtained from the Government. Turning to the technical high schools, that of Berlin, with a total income of 69,077*l.*, received 33,675*l.*; Hanover, total income 25,240*l.*, obtained 15,094*l.*; while Aachen, having an income of 22,998*l.*, received 16,581*l.* from the Government. The teaching staff of the chemistry department—I have not the numbers for the other departments—is also on an equally lavish scale, as the appended table shows:—

		Teaching Staff.		Students.
Heidelberg University	...	10	...	315
Strasburg University	...	7	...	48
Berlin Polytechnic ...	...	44	...	278
Stuttgart Polytechnic	...	10	...	88
Karlsruhe Polytechnic	...	15	...	139

It has already been mentioned that the technical high schools are taking a more and more leading place; this is shown by the fact that during the last seventeen years the students at the technical high schools have increased 206 per cent., whereas at the Universities the increase is only 12 per cent. In some chemical works preference is given to students who have studied at the technical high schools, one reason being that technical high schools devote much more attention to the teaching of technology. It is estimated that there are in Germany about 4500 trained chemists who have had the full courses at the Universities or technical high schools. But notwithstanding this vast array of expert technical chemists and the preeminent place which German chemical industries have obtained, in chemical industrial circles in Germany there is a widespread feeling that there must be no resting on their oars, but that increased facilities for technical education must be obtained, and it is felt that, unless the Universities devote more attention to technology, the diminution in the number of students will in the course of ten or fifteen years react most unfavourably upon the German chemical industries. How much more so is this the case in our own country, where chemical technology is rarely taught? At our Universities and polytechnics we appoint *one* professor, who has to teach all the branches of chemistry. In Germany there is a professor set apart to teach technology, a

[1] The Technical Education Board of London do their best to remedy defects in equipment, but their funds are not unlimited, and it is not their province to pay for the general upkeep of the institutions.

[2] This does not include the day training college, which has an income of 5400*l.* and 3679*l.* in the form of grants from the Education Department.

special lecturer for physical chemistry, and very often a professor for organic and another for inorganic chemistry, beside numerous lecturers on different branches of the subject.

The German nation, which has placed its primary and technical education on a sound basis, has been richly rewarded. In 1897 the total production of the German chemical works was 47,391,132*l*. Within the last twenty years many new and flourishing industries have been started, the foundation of which has been entirely due to the results of chemical research. Again, one has only to glance at the appended list, which shows the dividends of some of the larger chemical works, all of which employ a large staff of fully trained chemists, to recognise that science and successful commerce go hand-in-hand:—

Name of works	Dividends 1893 Per cent.	1896 Per cent.	1899 Per cent.
Höchst Colour Works	28	28	26
Baden Aniline and Soda Works	27	26	24
Elberfeld Colour Works	18	18	18
Schering and Co., Berlin	19	11	12
Nobel and Co., Hamburg	21½	13	18
Munich Paper Works	15	16	18
Rositz Sugar Works	3	12	13

In this country the Government relies too much upon private initiative and individual generosity. Because nearly all the pioneering labour and many of the most brilliant scientific results of the past century have, so far as this country is concerned, been conducted by private individuals who were fired with the restless and resistless energy of genius, the Government and the manufacturers wrap themselves in an impenetrable armour of self-complacency and blind optimism. Our forefathers, they say, had practically no scientific education, and see how they excelled in invention and obtained the control of the commercial world. Let them, however, remember that in those days the Germans had also practically no scientific education, neither was their empire consolidated as it is at the present moment. So long as the Government refuses to recognise the needs of science, and manufacturers, with fatuous obstinacy, refusing to learn from the experience of other nations, look upon chemists as expensive luxuries, so long will chemical trade remain in the hand of our rivals.

F. MOLLWO PERKIN.

THE GEOLOGICAL SURVEY OF THE UNITED STATES.

IN NATURE for December 27, 1900, we noticed the first and sixth parts of the Twentieth Annual Report of the United States Geological Survey. We have now received the remaining volumes. Part ii., comprising "General Geology and Palæontology," consists of 953 pages with 193 plates. It includes a brief article on the geology of the Philippine Islands, by Mr. G. F. Becker; but as we have since received the full report (noticed further on), we may pass on to the next paper by Mr. J. Nelson Dale, a study of Bird Mountain, Vermont. This mountain, the summit of which is 2200 feet high, lies in the Taconic Range, and consists of about 500 feet of Ordovician grit and conglomerate interbedded with muscovite-schist, and underlain by similar schist with beds of quartzite. The author discusses the origin of the mountain, the features of which have been largely sculptured by glacial action. The Devonian fossils from south-western Colorado, constituting the fauna of the Ouray Limestone, are described by Mr. George H. Girty. Although by some authorities regarded as Carboniferous, Mr. Girty considers that the fauna indicates late Middle or early Upper Devonian. Varieties of *Spirifer disjunctus* occur, together with numerous other fossils.

A preliminary paper on the geology of the Cascade Mountains in Northern Washington is contributed by Mr. Israel C. Russell. The rocks comprise granite, various schists, greenstone and serpentine of unknown age, and also a great extent of slightly altered and unaltered sedimentary strata, mainly Cretaceous and Tertiary, with some possibly of Jura-Trias age. The granites and allied rocks are usually jointed in a conspicuous manner. The influences of these joints on the rugged spires and cathedral-like forms resulting from weathering are among the most characteristic details in the magnificent scenery of the Cascade Mountains. The structure of the range is highly complex. This is briefly described, and fuller particulars are given of the striking effects of glaciation.

Mr. Lester F. Ward is the author of an elaborate essay on the older Mesozoic floras of the United States, Triassic and Jurassic; and Mr. David White deals with the stratigraphic succession of the fossil floras of the Pottsville formation in the southern anthracite coal-field of Pennsylvania. The plants of this Carboniferous formation exhibit a rapid development, and a series of changes or modifications, which are considered of high stratigraphic value.

Part iii. deals with the "Precious-metal Mining Districts." The Bohemia mining region of western Oregon is described by Mr. J. S. Diller. It is situated at an altitude of between 4000 and 6000 feet above the sea, along the crest of the Calapooya Mountain, and upon both slopes. The mountain is composed of lavas like those of the Cascade Range. Generally the sheets of lava are very irregular. The lava filling the throat of a once active volcano has in the case of the Cougar Rock made a prominent peak, while in Bear Bones Rock it presents a conspicuous columnar structure. The streams have cut deep, narrow valleys, approaching canyons in character. These expose rocks to a depth of more than 2000 feet—comprising lavas (chiefly andesites), vein matter and stratified fragmental volcanic material. It is probable that volcanoes were active in Eocene times, and continued so during the Miocene period. The veins lie along narrow, irregular joint-planes in which there has been much crushing of rock material. The principal gangue is quartz, containing at a depth much pyrites and other sulphides in which gold occurs; while near the surface the gold is native, finely filamentous and distributed through iron-stained quartz. The output in this region has been chiefly from one mine during the last few years. Mr. F. H. Knowlton contributes an account of the Miocene plants of the Cascade Range.

The gold and silver veins of Silver City, De Lamar, and other mining districts in western-central Idaho are reported on by Mr. Waldemar Lindgren. The area includes four types of scenery: (1) the Snake River valley, extensive arid plains underlain by Neocene lake-beds with intercalated flows of basalt, which are cut into to a depth of from 400 to 1000 feet; (2) the Owyhee Range, a steep granite ridge covered by broad areas of Neocene lavas; (3) a great central granite region north of the Snake River, with bordering sedimentary rocks, probably Palæozoic, showing extensive contact metamorphism: the whole described as a veritable labyrinth of ridges and peaks separated by sharply-cut canyons, the higher ridges attaining elevations of 12,000 feet, and evidently an old plateau with an intricate and deeply-cut drainage system; and (4) a more recent plateau of the Columbia lava flows, of Miocene age.

The mineral deposits of the great granite area are fissure veins, containing gold and silver in a quartzose gangue. The adjoining sedimentary areas carry either veins or contact deposits of irregular shape, generally containing silver, lead, zinc and copper. The Tertiary volcanic rocks contain in places gold and silver veins

of peculiar character. Considerable amounts of placer deposits are found in the gravels associated with the Neocene lake-beds. It is considered that some of the mineral veins may be of Cretaceous or Eocene age, some may be older, and others are post-Miocene.

Mr. W. H. Weed describes the geology of the Little Belt Mountains, Montana, an elevated and eroded plateau region. Gneisses and schists form a central core, upon which rest a great variety of sedimentary rocks, penetrated by igneous rocks, which appear as dykes, sills and laccolites. Silver-lead ores, gold, iron ores and sapphire mines are described. The petrography of the igneous rocks is dealt with by Mr. L. V. Pirsson, who describes syenite, monzonite, shonkinite (a basic granitoid rock) and many other rocks. The rock in which the sapphires occur is allied to the minettes and shonkinite, and it appears to have derived its alumina from clay-shales through which it was intruded; the molten rock on its way incorporating shale-fragments in its mass. The many subjects dealt with in this elaborate memoir are fully illustrated with views, diagrams and plates of microscopic sections of rocks.

Part iv., on "Hydrography," deals with stream measurements and reservoir sites, and there is a special article on Nicaragua. The volume is well illustrated with views and diagrams. Part v. is on "Forest Reserves," and has excellent maps, views of scenery and woodland, and notes on soils and timber-trees. Part vii., "Explorations in Alaska," is a volume of more than 500 pages, profusely illustrated, and dealing with the topography, geology, agriculture, game, and inhabitants.

Mr. George H. Eldridge gives an account of a reconnaissance in the Sushitna Basin and adjacent territory. Here the geological formations include granite, schists and slates, and a series of conglomerates and sandstones of undetermined age; also sandstones and shales with coal-seams belonging to the Eocene; and sundry Drift deposits. Traces of gold occur in the pyritiferous quartz of the slate series, but elsewhere in placer deposits. The coal is a low-grade lignite.

Mr. J. E. Spurr deals with south-western Alaska, and his report is accompanied by a coloured geological map showing gneiss and schists, Silurian, Carboniferous-Devonian, Jurassic, Cretaceous, Eocene and later deposits, as well as Tertiary intrusive and volcanic rocks. He describes as fully as possible the sedimentary and eruptive rocks, and with regard to the latter employs the name Alaskite group for certain quartz-alkali-felspar rocks, and Belugite group for rocks transitional between the diabasic and dioritic families.

Mr. W. C. Mendenhall describes the country from Resurrection Bay to the Tanana River; Mr. F. C. Schrader deals with a part of Prince William Sound and the Copper River district; and Mr. A. H. Brooks with the White and Tanana River basins.

One general conclusion is that Alaska is eminently not the place for the haphazard or untrained prospector; and that in the long run only those who have the intelligence, training, and patience to study the conditions of the occurrence of gold can hope to succeed.

We have received the first and sixth parts of the Twenty-first Annual Report. In Part i. the director, Mr. Charles D. Walcott, refers to the reorganisation of the geological branch which came into effect in July 1900. The need was felt of closer and permanent supervision in scientific lines, and the Geological Survey was subdivided and each division placed in charge of a specialist as follows:—Areal Geology (stratigraphy, structure and pre-Pleistocene physiography), Bailey Willis; Pleistocene Geology, T. C. Chamberlin; Palæontology, T. W. Stanton; pre-Cambrian and Metamorphic Geology, C. R. Van Hise; Mining and Mineral Resources (distribution and production of economic minerals), D. T. Day; Economic Geology (metalliferous ores), S. F. Emmons (non-metalliferous deposits, &c.), C. W. Hayes; Physical and Chemical Research, G. F. Becher. Accompanying this volume is an obituary notice of Prof. O. C. Marsh, prepared by Mr. Arnold Hague.

Part vi. consists of two volumes, dealing with mineral resources. The great demand for mineral products led to an increase in 1899 over 1898 of more than 10 per cent. in output and of more than 39 per cent. in value. Nearly every important "mineral" participated in this increase, notably pig iron, copper, coal, natural gas, petroleum, cement and stone. Lead showed a decline. The value of grindstones was large and that of oilstones and whetstones the largest on record. Pigments, again, were in great demand. Fuller's earth was produced in less quantity and more was imported; it is used partly for decolorising vegetable oils.

We have also received a reprint from the Twenty-first Annual Report, Part iii. (1901)—a Report on the Geology of the Philippine Islands, by Mr. George F. Becker, with notes on the Tertiary fossils, by Mr. K. Martin. In these islands schists and massive crystalline rocks occur, together with diorites, diabases, and gabbros. Of newer volcanic rocks there are basalt, andesite, dacite, and probably trachyte and rhyolite. A considerable number of volcanoes have ejected ash and lava recently, or since the occupation of the country by the Spaniards. Tertiary strata from Eocene upwards are well developed in the islands, but have been imperfectly studied. Of mineral resources there is a brown coal of Tertiary age, while gold-mining is an ancient industry. Even the tricks of the trade are not unknown to the natives, and they "nearly succeeded in inducing some American officers to take an interest in gravel salted with brass filings." The auriferous deposits include veins, placers, and river sands. The occurrence of copper, argentiferous lead-ore, and magnetic iron-ore is noticed.

In addition to the Reports already mentioned, we have received Nos. 163 to 176 of the *Bulletin* of the United States Geological Survey, all published in 1900. These deal with a variety of subjects, and not the least useful is that by Mr. F. B. Weeks (No. 172)—a bibliography of American geology for 1899, in which 799 articles are listed and indexed.

Of purely geological articles we have a reconnaissance in the Rio Grande coal-fields of Texas (No. 164), by Mr. T. V. Vaughan. Although the State is by far the largest in the Union, embracing a quarter of a million square miles of territory, it stands low in the scale of coal producers. The coals occur in strata of Upper Cretaceous and Eocene age, and they vary in thickness from a few inches up to 7 feet. Details are given of the strata and their fossils, and it is remarked that there are not yet sufficient data to trace accurately the boundary between the Cretaceous and Eocene. The Cretaceous coals of the Eagle Pass coal-field are regarded as of anthracitic type, and as by far the best fuel in America except the true anthracites of Pennsylvania. The Eocene coal is strictly speaking a lignite. Mr. E. C. E. Lord contributes a report on the igneous rocks of the San Carlos coal-field. These rocks indicate late Cretaceous or early Tertiary lava flows, and comprise rhyolite breccia, quartz-pantellerite, and basalt.

Contributions to the geology of Maine are made (in No. 165) by Mr. H. S. Williams and Mr. H. E. Gregory. Mr. Williams deals with the Silurian and Devonian faunas, and enters into a discussion of the characters and evolution of the Rhynchonellas. He remarks that there is no question as to the great importance of internal characters for purposes of determining the genetic relationship of organisms; but it is also a fact that the external characters do not cease to be of similar value. He points out that the taxonomic rank of characters rests

primarily upon their relative fixity, and not upon their supposed importance in the individual economy of the organism. Generic characters to be of taxonomic value must be distinguished from varietal and specific characters by their greater fixity, or what may be defined as their more exact reproduction or transmission in generation. He further remarks that the attempt closely to correlate specimens with some particular species diverts the attention from the evolutional laws which the evidence contains and illustrates. The study of a single group of species demonstrates the fact that the evolutional stage of the group is indicated with precision, independent of the names of the species, and independent of the fact that the specimens actually present in the Maine fauna agree precisely in scarcely a single case with those of any fauna in New York.

Mr. Gregory reports on the geology of the Aroostook volcanic area. North-eastern Maine is essentially a region of sedimentary rocks, with prominent exposures of igneous rocks in Castle Hill and Mapleton townships. This area appears to have been a distinct centre of volcanic activity. Rhyolites, trachytes and andesites are described. Elsewhere there are tracts of granite and other igneous rocks.

Of purely palæontological papers there is an account of the flora of the Montana formation (No. 163) by Mr. F. H. Knowlton. The formation is approximately of Laramie (late Cretaceous) age. There is also an elaborate synopsis of American fossil Bryozoa (No. 173) by Mr. J. M. Nickles and Mr. Ray S. Bassler.

Contributions to chemistry and mineralogy, with analyses of rocks, are given (in Nos. 167 and 168) by Mr. F. M. Clarke. Various crystalline and sedimentary rocks, soils, and meteorites, are dealt with. Mr. W. F. Hillebrand treats of some principles and methods of rock analysis (in No. 176). Of miscellaneous reports we have a gazetteer of Utah (No. 166), altitudes in Alaska (No. 169), and other topographical papers (Nos. 170, 171, 174 and 175).

Several Monographs published by the U.S. Geological Survey have also been received. Monograph No. 39 (1900) contains an account of the Eocene and Lower Oligocene Coral Faunas of the United States with descriptions of a few doubtfully Cretaceous species, by Mr. T. Wayland Vaughan. The author laments that the classification of corals is in a most unsatisfactory condition, but he has described his material with all possible care in the hope that ere long some one may be able to give a classification based on the actual phylogenetic grouping of the various genera. The larger the number of specimens the more difficult it is to define species: Mr. Vaughan has tried to be conservative, and when a form in one horizon grades into a form in the horizon next above, he has named them varieties of the same species, even when the variety possesses an individuality that makes it easily recognisable.

In Monograph No. 40 (1900) Mr. S. H. Scudder deals with certain Coleoptera from the Tertiary deposits at Florissant, Colorado, and gives a systematic list of the non-rhynchophorous Tertiary Coleoptera of North America.

NOTES.

H.R.H. THE PRINCE OF WALES has accepted the presidency of the Society of Arts, which was vacated by His Majesty the King on his accession.

DR. WILLIAM SOMERVILLE, late professor of agriculture at the University of Cambridge, has been appointed to be an assistant secretary to the Board of Agriculture in succession to Sir Jacob Wilson, who has retired.

DR. ARTHUR SMITH WOODWARD, F.R.S., has been appointed keeper of the Geological Department of the British Museum (Natural History), South Kensington, in succession to Dr. Henry Woodward, who retired on November 23 after a service of nearly forty-four years. Curiously enough, there is no family relationship between the present and past keepers.

MAJOR A. W. ALCOCK, F.R.S., Superintendent of the Indian Museum, Calcutta, informs us, that Mr. L. de Niceville died at Calcutta of fever contracted in the Darjeeling Terai, on December 3.

IT is announced by Dr. D. Morris that the fourth annual West Indian Agricultural Conference will be held at Barbados on January 4 and 6, 1902. The object of the conference, as laid down by the Secretary of State, is the reading of papers and discussion on the scientific and economic aspects of the sugar-cane and other industries. It is hoped that the subjects brought forward will be dealt with from a thoroughly practical point of view and with a full knowledge of the requirements and circumstances of each colony concerned.

THE death of Mr. James G. Shipman, F.G.S., deprives geological science of an ardent local worker, who did much to enlarge our knowledge of the rocks and fossils of the neighbourhood of Nottingham. He commenced life in comparatively humble circumstances; he was apprenticed to the printing trade, and was finally given a post on the sub-editorial staff of the Nottingham *Daily Express*. His interest in geology was aroused by lectures given more than thirty years ago by the late Edward Wilson. Thereafter he devoted himself to the subject with remarkable assiduity. His leisure hours were spent in studying all sections within reach of Nottingham, and he contributed a number of papers, chiefly on the Drift and Triassic deposits, to the Annual Report and *Transactions* of the Nottingham Naturalists' Society. Latterly he had paid much attention to the structure of the Nottingham and Derbyshire Coal-field, and had qualified himself to give expert advice on water-supply. He died on November 21, aged fifty-three.

A REUTER'S telegram states that Mr. William Bruce, the leader of the Scottish Antarctic expedition, has purchased the Norwegian steam whaler *Hecla* for his forthcoming expedition to South Polar regions. The *Antarctic*, with Prof. Nordenskjöld's South Polar expedition on board, left Buenos Ayres on Friday for the Falkland Islands. The *Discovery* left Lyttelton for Dunedin on Saturday afternoon, and has by now sailed for the Antarctic.

PROF. H. HERGESELL, president of the International Aëronautical Committee, informs us that arrangements are being made to continue the manned and unmanned balloon ascents during 1902, the dates proposed being the first Thursday in each month, except January, when the second Thursday is selected. Since November 7, 1900, 120 ascents have been made; the observations are now being discussed and will throw much light on the physics of the upper air. It is proposed to hold a meeting of the Committee next year in Berlin, when questions relating to new thermometers, observations of atmospheric electricity and magnetism will be discussed.

IN connection with the valuable series of forty years' observations taken at Camden Square (N.W. London), *Symons's Meteorological Magazine* for December contains the monthly results and extremes of solar temperatures for twenty-eight years commencing with 1870, made by both black and bright bulb radiation thermometers. The following are some of the values obtained by the black bulb *in vacuo*:—Highest monthly average, 123°·4, absolute maximum, 137°·7, both in July. Lowest monthly mean, 36°·9, absolute minimum, 24°·8, both in Decem-

ber. The absolute extremes by the bright bulb *in vacuo*—an instrument not in general use—were 105°·4 in July and 22°·5 in January.

THE fifth list of current papers collected and discussed by Mr. H. C. Russell, Government Astronomer of New South Wales, covers a period of thirteen months, from October, 1899, to November, 1900. No less than 448 papers were thrown overboard, mostly in the southern Indian Ocean, but only eighty-six of these were recovered; 106 papers were received during the period mentioned, but twenty of them had been more than thirteen months drifting. Three of the papers set afloat near the Cocos Islands landed on Africa and showed the high rates of 18·3, 20·6 and 25·4 miles a day, the latter being the record drift obtained by Mr. Russell. The following summary of the average drifts obtained in the Indian Ocean during the years 1893–1900 is very interesting:—from the equator to 10° S., 13·3 miles a day; from 10° to 30° S., 16·6 miles; from 33° to 43° S., 7·6 miles; from 43° to 50° S., 9·4 miles. Among the last series of papers, one thrown overboard off Cape Horn found its way to the west coast of Africa, in Ashantee, the drift in a straight line being 5350 miles in a N.N.W. direction, the rate per day being 10·1 miles. The track and daily position of the s.s. *Waikato* are shown on a chart and will be useful for other steamers which may have to drift in the same waters. This vessel broke her main shaft on June 5, 1899, in lat. 37° 30′ S., long. 21° 0′ E., and drifted about in the Indian Ocean until September 15, when her position was lat. 39° 29′ S., long. 64° 30′ E.

THE production of motive power from blast-furnace gases formed the subject of a paper by Mr. Bryan Donkin, read before the Institution of Civil Engineers on December 17. Only within the past few years has it been realised that power can be produced economically and effectively by utilising the gases from blast-furnaces to drive gas-engines. As the annual production of iron from blast-furnaces throughout the world is forty million tons, this new application of motive power is capable of immense development. The gases given off from these furnaces during the process of smelting iron are practically the same as weak producer-gas. Until within about half a century ago they were all wasted. A part was next utilised under boilers to generate steam to drive the blowing engines and part to heat the air-blast; but after supplying these requirements a considerable surplus was available. Successful efforts have been made, first to use this surplus in gas-engine cylinders, to obtain power, and next to discard steam-engines, boilers and chimneys entirely, and utilise all the gas in this way. A great impetus has been given to the construction of large motors by the discovery that blast-furnace gases can be used to drive them. They are now made in sizes up to 1000 h.p. and 1500 h.p., and still larger powers are in contemplation, while the difficulty of starting these large engines has been successfully overcome. Mr. Donkin gave some account of the very rapid progress made in this class of work on the continent. Many of the large firms in Germany and Belgium are now busily employed. The Gasmotoren-Fabrik Deutz has numerous orders for motors from 500 h.p. to 1000 h.p., while at Seraing, in Belgium, an aggregate of 39,000 h.p. has been bespoken. Messrs. Körting, of Hanover, have also supplied several engines, and the Deutsche Kraftgas-Gesellschaft propose to construct motors up to 1500 h.p. and 2000 h.p. It was remarked that England and Scotland seem rather slow to utilise these gases.

FROM an article in *Transport* it appears that oil has been very successfully used as fuel for steamers. An inspection of the *Clam* steamer, belonging to the Shell Transport Company, was recently made prior to her departure from the Thames for Philadelphia. It was shown from the vessel's log that for two years the steamer has been using oil instead of coal, and that it was found that eighteen tons of oil gave off more heat than twenty-eight tons of coal, and with improvements recently made it was expected that still better results would be obtained. The employment of liquid fuel also led to a considerable economy of labour, got rid of many of the difficulties attending the stokehold, and allowed a considerable addition to the space available for cargo. The *Clam* has relied solely upon obtaining a supply of oil from Borneo, and the company claim that from their wells in that country they can supply 100,000 tons of oil a day. The company are so satisfied with the results obtained that they intend to send to sea a fleet of eighteen steamers burning oil as fuel. In the United States oil is very largely superseding coal for locomotive engines, especially for street railways. In this country the Great Eastern Railway Company have many of their engines fitted for using oil as fuel, the advantage of which was found very great during the late high price of coal.

THE feature of the North Atlantic and Mediterranean pilot chart for January, issued by the Meteorological Office, is the introduction of the curves of equal magnetic variation for the whole of the sea space. They are for the year 1905, and are drawn for each 2°. This addition makes the charts far more complete, and it will be greatly appreciated by mariners and others. In some quarters the numerous wrecks occurring on the Newfoundland coast have been attributed to errors in the variation in that locality, but it is pointed out that it is sufficiently accurately determined for navigational purposes. The very variable currents experienced in the neighbourhood are the most probable cause of so many disasters, and during the prevalence of thick weather mariners are therefore urged on no account to neglect the use of the lead, as it is impossible to foretell with certainty how the current has been running, the prevailing southerly set being sometimes replaced by a north-going one, which would tend to drift a vessel up the coast between Cape Race and St. John's. Being midwinter, fog is by no means frequent on the banks, barely exceeding 10 per cent. of the weather observations. It is, however, interesting to notice that the season of least fog in the Newfoundland region is the season of greatest frequency of dense "red dust" clouds on the eastern side of the ocean, off Africa. Four years ago the Cape liners were delayed as much as three days by a thick dust fog, which extended for a distance of about 2000 miles southward from Madeira. The coasts of Trinidad and Guiana are at this season subject to rollers, which are dangerous to heavily laden small craft. There are some notes on the more salient features of the currents in various localities; the anti-cyclonic type of weather over western Europe is illustrated by an inset chart, the remarks showing that in January the barometer may rise as high as 31·1 in. within the British Isles; and the prevailing winds and the movements of the centres of cyclonic systems in the Mediterranean region during January are explained.

WE have received a copy of the tide table for Halifax, Quebec, St. John (N.B.) and Father Point, issued by the Tidal Survey branch of the Department of Marine and Fisheries, Canada, for the year 1902. This contains extended new information on the tides and currents of the St. Lawrence, based upon investigations made by the Tidal Survey in the season of 1900.

HERR H. WIECHEL contributes to the *Proceedings* of the "Isis" Natural History Society in Dresden an interesting paper on the ancient roads of Saxony. A sketch-map, elaborated from the "Oberreit'schen" atlas, which is based on the engineer surveys of about the year 1780, shows the chief roadways existing during the period A.D. 800 to 1200, and the paper discusses the routes, topographical names, &c., in detail.

UNTIL a few months ago, Tahiti could be reached from the United States only by a sailing schooner from San Francisco in a voyage of six or seven weeks. The French Government has now arranged for a steamship to leave San Francisco for Tahiti every five weeks, and as the voyage only lasts about eleven days, many travellers will probably take advantage of it. The development of means of communication will, however, produce decided changes in the ways and customs of the natives, and this induced Dr. S. P. Langley to visit Tahiti by the first trip of the new line. An interesting diary of the voyage and visit kept by him is printed, with illustrations, in the December number of the *National Geographic Magazine*. It will be remembered that Dr. Langley described in NATURE, of August 22 (vol. lxiv. p. 397), the fire-walk ceremony witnessed by him during his visit; and his observations showed conclusively that the alleged miraculous power of resisting fire possessed by the performers has no foundation in fact. The success of the fire-walk depends upon the low thermal conductivity of the stones among which the fire is kindled, as Dr. Langley explained in his letter to NATURE, and describes in his diary. Other ordeals by fire, which have been successfully undergone, such as the burning fiery furnace in which Shadrach, Meshach and Abednego stood unharmed could probably be explained by reference to natural causes in a similar way, if sufficient evidence were available.

IN a paper on "The Results of some Recent Researches in Electricity," published by the Warrington Literary and Philosophical Society, Mr. J. Reginald Ashworth has presented a summary of the properties of different kinds of rays in the following simple tabular form:—

Name of Ray.	Kathode.	Becquerel.	Röntgen.	Ultra-violet Light.	Red Light.
Existence of Interference, Polarisation, Reflection, Refraction.	o	o	o	×	×
Photographic Effect	×	×	×	×	o
Excite Phosphorescence	×	×	×	×	o
Render Air Conductive	×	×	×	×	o
Penetrate Opaque bodies	×	×	×	o	o
Undergo Deflection by Magnetism	×	×	o	o	o
Velocity relative to that of Light ...	$\frac{1}{7}$	$\frac{1}{2}$	1	1	1

In this table × denotes the existence and o the non-existence of the several properties, and Mr. Ashworth quotes authorities for the statements as to the velocities of the rays.

IN a paper published in the *Verhandlungen* of the Naturforschenden Gesellschaft in Basle, Messrs. Paul and Fritz Sarasin suggest that the low temperature of a glacial period may be due to the obscuration of the sun's rays caused by large quantities of dust-particles suspended in the atmosphere. The phenomena associated with the Krakatoa eruption are discussed, and the widespread effects of this single eruption compared with what may be supposed to have been the result of volcanic activity on the scale known to have prevailed at the end of the Pliocene period.

PROF. W. M. DAVIS contributes a paper to the November number of *La Géographie* on the lessons of the Grand Cañon of Colorado. The conclusions arrived at by the author during a recent visit to this region, and published in the *Bulletin* of the Museum of Comparative Zoology at Harvard College, are used to elucidate its development, beginning with the formation of the *massif* of archæan rock which underlies it, and to show that the cutting of the great gorges is only the last, and by no means the longest, stage of a varied history. Prof. Davis again sets forth his view of the relations between geomorphology and geology, and urges the importance of the former as a branch of geography.

JUDGING from the *Schriften* for 1899, which has just reached us, the Natural History Society of Danzig seems to be in a flourishing condition, the number of papers in the volume before us being very large. Many are of a purely local nature, and some valuable contributions are made to the history of the fauna and flora of the district. Herr E. H. Rübsaämen describes, for instance, the insects and other arthropods obtained during two journeys in the Tuchel forest made in 1896 and 1897; while Herr F. Braun discourses on the ornithology of the Elbing range. Of wider interest is a paper, by Herr E. Treptow, on the progress and results of mining throughout the world during the nineteenth century. An elaborate table of the gold-production of the different countries of the world during the period in question is appended.

IN our last week's issue we noticed two papers from the *Proceedings* of the Philadelphia Academy, of which we had then received only some advance-sheets. The complete current issue (vol. liii. part ii.) has now reached us. Among the more important papers is one by Mr. J. A. G. Rehn on the earwigs, cockroaches, mantids and stick-insects collected by Dr. Donaldson Smith in north-east Africa. Altogether 239 specimens of Orthoptera were collected, of which the grasshoppers, crickets and locusts are reserved for a second paper. A considerable number of species are described as new. The author has also some notes on that remarkable South American bat known as *Centurio senex*, which is regarded as forming a subfamily by itself. In addition to the one on Liu-Kiu Clausilias referred to in our last issue, Mr. Pilsbry has several papers on new molluscs from Japan and the surrounding seas, in the first of which certain Liu-Kiu forms are also described. They are illustrated by several plates. Dr. H. C. Chapman's paper on the placenta and fœtus of the six-banded armadillo is also worthy of note. To ichthyologists Mr. H. W. Fowler's notes on type-specimens of fishes in the Academy's collection will be of interest.

NUMEROUS surveying and drawing instruments—some of a novel character—are mentioned and illustrated in the catalogue just issued by Messrs. W. F. Stanley and Co. Students of branches of engineering, architecture, and other subjects in which exactness of observation and design are required, will find that the catalogue contains many desirable instruments.

IT requires a philosophic spirit to read with patience and profit Mr. Howard Collins's "Epitome of the Synthetic Philosophy of Herbert Spencer." Yet the fifth edition of this summary of Mr. Spencer's completed and revised survey of the universe has now been published by Messrs. Williams and Norgate, thus showing that there are many students who find it of service. Broadly speaking, the book may be described as a collection of abstract propositions, the proofs of which will be found in the ten volumes in which "The Synthetic Philosophy" is elaborated. Mr. Collins manages to give the essence of this work in his volume of nearly 700 pages. "Indeed," remarks Mr. Spencer in a preface, "I have been somewhat surprised that it has proved possible to put so much in so small a space without sacrifice of intelligibility."

THE latest number of the *Proceedings* of the Society for Psychical Research contains 650 pages, in which Prof. J. H. Hyslop gives "A Further Record of Observations of Certain Trance Phenomena," the medium being Mrs. Piper. It need scarcely be said that many of the incidents and results described appear trivial to investigators more familiar with the material sciences than mediumistic performances. A special frame of mind is required even to consider the phenomena patiently.

There seems to be no suspicion of fraud in the case of the phenomena with which Prof. Hyslop is concerned, so that, accepting the observations as records of actual occurrences, an explanation of them is required. The physiologist might be able to throw some light upon them, but he is told that the problem has gone far beyond physiology. "Only the psychologist can any longer deal with the complexities and significance of the Piper phenomena." Telepathy with its necessary adjuncts is also thrown overboard, and spiritism is held to provide a sufficient hypothesis for the data in hand until a better supersedes it. Upon this view there must be a survival of consciousness after death, in a form which is incomprehensible to materialistic philosophers. Prof. Hyslop defines his position as follows:—"I have given a preference for the spiritistic theory in explanation of my alleged facts, in order to force the issue on an important investigation and in order to devolve upon those who have not accepted any supernormal phenomena at all the duty of rescuing me from illusion." Unfortunately, it is not possible for every investigator to study such psychical phenomena as those described by Prof. Hyslop and thus test the value of the observations, so he usually has little interest in them.

Two papers on "La préparation industrielle et les principales applications des Gaz liquéfiés" are contributed by Prof. E. Mathias to the *Revue Générale des Sciences* of October 30 and November 15. Within the limits of twenty-eight pages of a review, much of that space being occupied by illustrations, it is impossible for the author to go deeply enough into the details of the subject to make his papers useful to those who have a fair acquaintance with them, and he does not always give the latest models of apparatus described by him. For general readers, however, the papers form a collection of facts and methods which will give them some insight into an interesting branch of work involving a clearer and closer connection than usual between scientific and industrial pursuits. In the first paper Prof. Mathias gives an account of various processes for liquefying the gases employed in refrigeration. In the second he describes and illustrates a number of machines in which the liquids are employed, and the purposes to which the results are or may be applied. In this connection it is to be regretted that the wild schemes of American company promoters are treated with so much respect, side by side with the descriptions of useful refrigerating machines being a serious account of two companies' automobiles designed to work with liquid air, with an illustration of one of them. The author does not give his readers fair guidance by stating that one of these companies is already in liquidation, and that neither of them has got better practical results than a specially arranged experimental run at a ruinous cost. Those who undertake to instruct the public in these matters with the voice of authority ought to make it clear that liquid air will be far too dear for employment as a source of power until an entirely new method of producing it is invented, and that no such method is as yet even in sight.

A CONSIDERABLE amount of work has been done recently on the ionising properties of liquefied gases, with especial reference to the hypothesis of the connection between the dielectric constant and the dissociating power. An interesting contribution by M. Centnerszwer to this field is contained in the current number of the *Zeitschrift für physikalische Chemie*, in which the conductivity of liquid cyanogen and of anhydrous hydrocyanic acid and of solutions of salts in these is given. In the case of cyanogen, the results of Gore, obtained in 1872, are extended and confirmed. Pure liquid cyanogen was found to have a scarcely measurable conductivity, its solvent power is very slight, and in no case could a proof of dissociation into ions be proved from the conductivity measurements Liquid hydrocyanic acid proved to have a measurable conductivity, which varied, however, in different experiments. Conductivity measurements were successfully carried out with solutions of potassium iodide and trimethylsulphine iodide, with the result that the solutions were found to possess about four times the conductivity of aqueous solutions of the same salts at equal temperatures and concentrations. In connection with the high value of the dielectric constant, these results furnish a new confirmation of the views of Thomson and Nernst on the parallelism between the dielectric constant and dissociating power.

TYCHO BRAHE IN PRAGUE.[1]

THE two papers mentioned below were published by the Bohemian Society of Science on the occasion of the 300th anniversary of Tycho's death. The first one forms a continuation of Prof. Studnicka's "Prager Tychoniana," published about a year ago (NATURE, lxiii. p. 206), and gives the titles of about a dozen volumes from Tycho's library which now belong to the University library at Prague. Several of these volumes contain three or four books bound together, with a few leaves of MS. inserted, among which is a MS. of eight pages (reproduced in facsimile) containing the calculation of the horoscope of Andreas Schoner, who is stated to have been born at Nuremberg on June 21, 1530. This is of interest, not only as showing the various steps of the *modus operandi* of judicial astrology, but also because the date of the younger Schoner's birth has hitherto been unknown (Poggendorff only gives the year 1528). In another volume of mathematical books there is a MS. note to the effect that $\pi = 88 : \sqrt{785}$, which value ($=3·1409$) does not seem to occur elsewhere. On the title page of this memoir is a figure of a medal which Tycho caused to be struck in 1595, probably to commemorate the completion of his star catalogue.

The second paper contains a report on the examination of Tycho Brahe's tomb in the Teyn Church at Prague in June last and on the state of his remains. As it was known that the bodies of some Protestants had been removed from the church after the battle of Prague in 1620 (though nobody has ever alleged that Tycho's tomb had been disturbed), the municipality of Prague allowed the tomb to be opened in order to ascertain whether the great astronomer's bones were still in it. On opening the floor of the church the vault was found to have partly fallen in, so that the two coffins were completely covered with débris and rubbish. We learn from another account (in the journal *Das Weltall*) that this is supposed to have happened in 1679, when part of the roof of the church took fire and fell down after being struck by lightning. The two coffins, which were falling to decay, contained the skeletons of a man and a woman, obviously Tycho and his wife, and slight remains of clothing on the former. Tycho's bones were taken out and put in a box in the vestry until a new metal coffin could be provided, but the writer of the report carried off the front part of Tycho's skull (all that was left of it) in order to examine, measure and clean it, whereby he found that the nose showed distinct signs of having been damaged (in the duel in Tycho's youth), while the green colour of the edges of the injured part no doubt was caused by some composition of copper in the false nose, which in course of time had been completely dissolved. Two illustrations give front and side views of the face, and the account in *Das Weltall* gives pictures of the same before and after the cleaning of the remains. Though we are assured in a footnote that everything was done in a dignified manner, this part of the report is painful to read and reminds one too much of the custom in ancient Brittany, where the inhabitants at the solstices or on the anniversary of the death of a relative took his bones out of the tribal ossuary, scraped them and put them back again. The whole proceeding may possibly have been interesting to an anthropologist (though Tycho did not belong to an extinct or otherwise peculiar race), but we think astronomers will be glad to know that their colleagues at the Prague Observatory had no part in this investigation.

[1] *Bericht über die astrologischen Studien des Reformators der beobachtenden Astronomie Tycho Brahe.* Von F. J. Studnička. Pp. 54. (Prag, 1901.)
Bericht über die Untersuchung der Gebeine Tycho Brahe's. Von Dr. H. Matiegka. Pp. 14. (Prag, 1901.)

EXPERIMENTAL PHONETICS.[1]

THE movements of the organs of voice and speech are so complicated as to require for their elucidation the application of many methods of research. When one speaks there are movements of the lips, tongue, soft palate and larynx, and sometimes movements of the muscles of expression. Then, again, there are special characteristics about vowel sounds which apparently distinguish these from the sounds of musical instruments. Thus questions arise as to the true nature of vowel-sounds and as to what is the physical constitution of a word of several syllables. It has also been suggested that language might be recorded, not by letters or syllables, but by signs or symbols which would indicate what had to be done by the vocal and articulating organs for the production of any given sound. There might thus be a physiological method of expressing speech by a series of alphabetical symbols for sounds varying in pitch, intensity and quality. It will be seen that experimental phonetics constitutes a wide field of research, not only of great scientific interest, but also one having practical aspects not at first apparent. From the nature of the investigation, also, the problems seem to be specially suited for the application of the graphic method of research.

In 1875, an investigation was carried out by Havet and Rosapelly[2] in the laboratory of Prof. Marey in Paris, in which the pressure of the air in the nose, the movements of the lips, and the vibrations of the larynx were simultaneously recorded. Special contrivances were devised for transmitting these movements to three of Marey's tambours, so arranged as to record on the surface of a blackened drum three superposed curves which indicated the order of succession, duration and intensity of the movements of the organs. The emission of air from the nostril indicated movements of the soft palate, and these were signalled by an indiarubber tube introduced into one nostril while the other end was connected with a tambour, as in Fig. 1. A small electromagnetic apparatus was placed over the larynx, and by making and breaking a current the vibrations of the larynx were transmitted to another tambour. The movements of the lips were recorded by a device which caused the pressures to act on a third tambour, as is shown in the figure.

This method was found to give characteristic tracings for the sounds of consonants, but the records obtained from vowel-sounds were all very much alike. It was also observed that if one of the tambours did not act, say the one recording the vibrations of the larynx, it was difficult to distinguish the tracings of certain consonantal sounds. Thus *p* resembled *b*, so far as the movements of the lips and the nasal pressures were concerned, but with *b* there is a vibration of the larynx as well, while this is absent in the tracing of *p*. In Fig. 2 is shown a table in which is depicted the traces obtained on uttering the vowel *a* either before or after various consonants. In these tracings, P *n* indicates nasal pressure, V *l* vibrations of the larynx, and M *l* movements of the mouth. Five examples are given of combinations of A with consonants. If there is no emission of air from the nostrils, the line P *n* is unbroken and horizontal, but if there is emission then an elevation is seen as in A 3 with *a m*, or *m a*. A sinuous line in V *l* shows that the larynx vibrates, but if there is no laryngeal vibration the line is straight. It will be observed that in some cases the larynx vibrates throughout all the experiment, as in A 2, while in others there is an interruption, as in B 1. The movements of the lips in M *l* show a curve which varies in amplitude and duration according as the lips are more or less approximated and according to the duration of complete or partial occlusion.

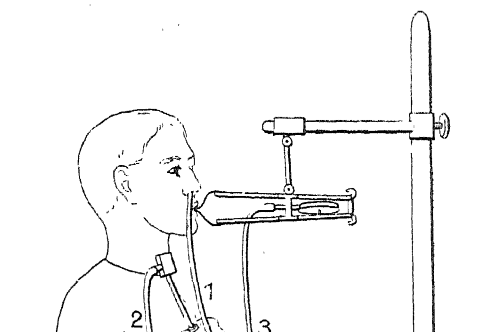
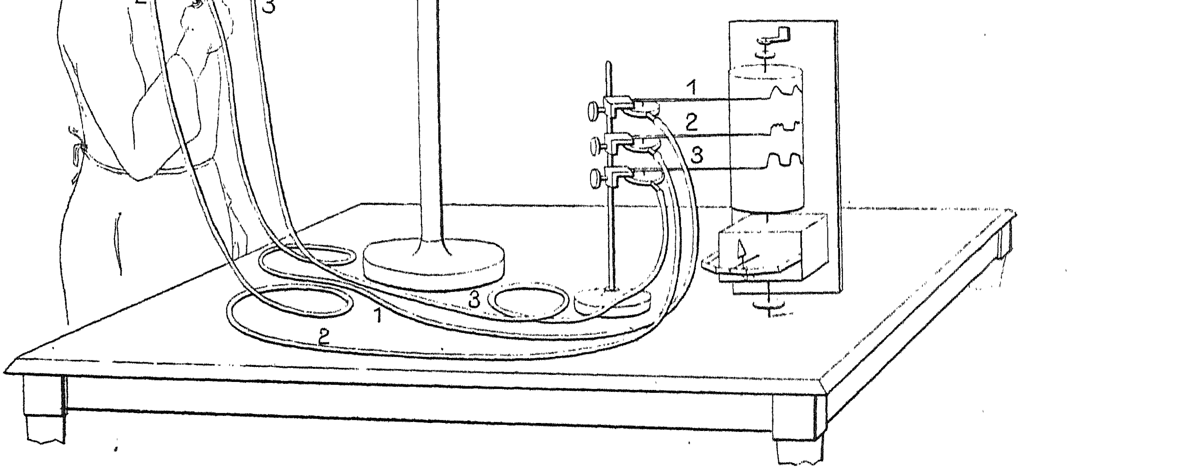

FIG. 1.—A method for recording simultaneously the different acts of speech: emission of air by the nares (tube and lever, 1) vibrations of the larynx (2), and movements of the lips (3).

These syllabic sounds may be termed *phones*. This research is an excellent example of the application of the graphic method to the movements of speech. The method has been much developed by Rousselot[1] in the Collège de France, where there now exists a special laboratory for research in phonetics.

Prof. Marey, whose earlier researches are well known to have had much to do with the development of the kinematograph, employed, so long ago as 1888, chronophotography to catch those evanescent changes of the countenance, the sum total of which give expression to the face in speech. In Fig. 3 are seen the changes of expression in a woman's face in speaking, during a period of half a second. If these successive pictures are projected by a lantern (Fig. 4) there is an animated face on the screen. In this way Marichelle succeeds in placing before the

[1] By Prof. John G. M'Kendrick, F.R.S. Read before the Section of Physiology at the meeting of the British Association in Glasgow, September 13. "Die Phonetische Literatur von 1876–1895." By Hermann Breymann (Leipzig, 1897); "The Articulation of Speech Sounds by Analphabetic Symbols." By Otto Jespersen (Marburg, 1889): "L'Inscription des Phénomènes Phonétique." By M. J. Marey (*Revue Générale des Sciences*, 15 et 30 Juin, 1898); "Studies from the Yale Psychological Laboratory." By E. W. Scripture (1899); "Théorie de la Formation des Voyelles." By Marage (Paris, prix Barbier, 1900); "La Parole d'après le Tracé du Phonographe." By H. Marichelle (Paris, 1897); "On Vowel Sounds." By J. G. M'Kendrick and A. A. Gray, Schäfer's "Text-Book of Physiology," vol. ii. p. 1206, in which the recent bibliography is given in detail.

[2] Rosapelly: "Inscription des Movements Phonétiques," in "Travaux de Laboratoire de M. Marey" (Paris, 1875).

[1] Rousselot: "Principes de Phonétique Expérimentale" (Paris, 1897).

eyes of deaf mutes images of the movements of speech which they are urged to imitate.

It is interesting, in the next place, to trace the efforts that have been made by physicists and physiologists to record the pressures produced by sound waves and more especially those of the voice. In 1858, Leon Scott invented the phonautograph, seen in Fig. 5. In its first form this instrument gave very imperfect tracings, but it is of great interest as being the forerunner of the phonograph. It was much improved by Rudolph König, of Paris. Donders,[1] in 1868, was the first to use the instrument in the investigation of vowel-tone. Then came the logograph of Barlow[2] in 1876, which was a membrane furnished with a rigid but light lever having its fulcrum at the edge of the membrane while the power was applied from the centre of the membrane. This gave more accurate tracings, that is to say, tracings that indicated with more precision the variations of pressure on the membrane. Examples are given in Figs. 6, 7, and 8.

In Fig. 6 at A the membrane is at rest; at B the lever is raised by the sudden emission of the consonant *b*, and this is succeeded by the prolonged vibration of the vowel *e*. Fig. 7 gives a different picture for *e b*; A is the vowel *e*; B the closure of the lips at the beginning of the consonant; this closure lasts during C, and D is due to the elasticity of the air compressed in the mouth. In Fig. 8, *b e b*, we find the elements of Figs. 6 and 7. By the logograph the consonantal sounds were alone depicted, the records of the vowels being very imperfect.

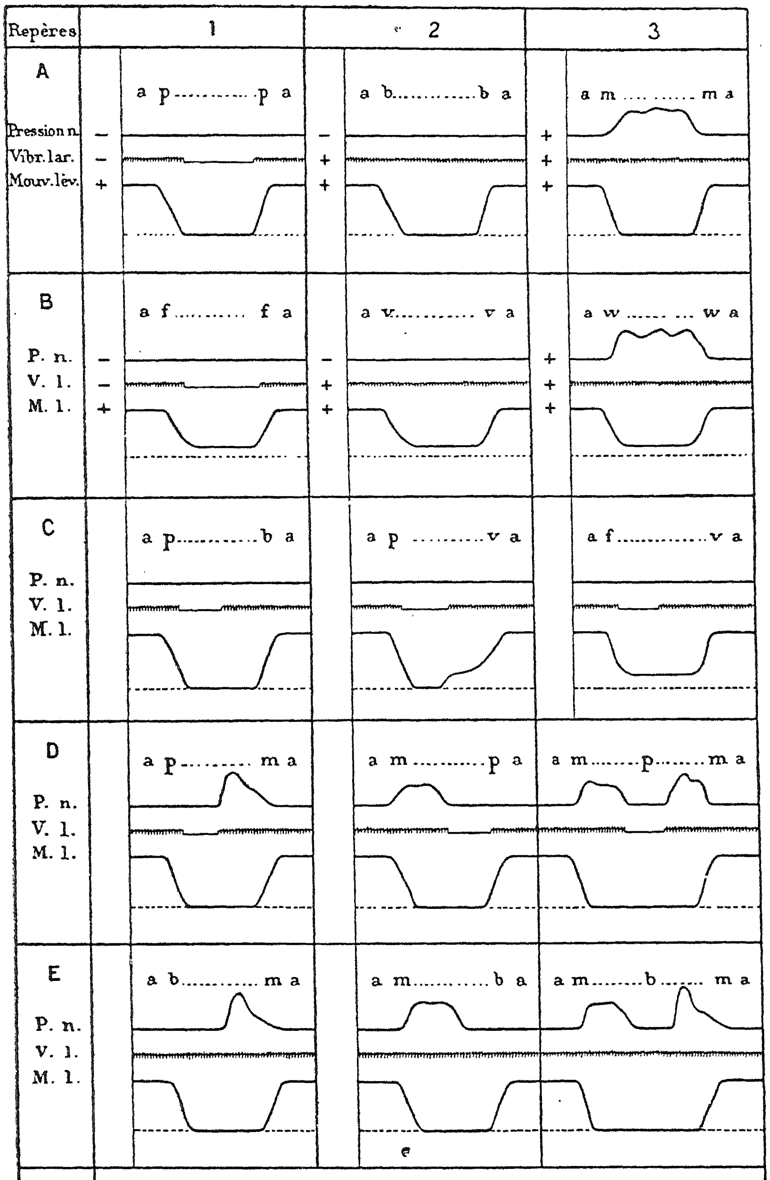

FIG. 2.—Tracings of nasal, laryngeal and labial movements in the pronunciation of various phones.

There was still a demand for a recorder of greater accuracy. Schneebeli,[1] in 1878, devised an instrument seen in Fig. 9. From the centre of a parchment membrane arises a thin but rigid steel plate; attached to this, near the point, is another steel plate passing horizontally from the edge of the metallic ring carrying the membrane. The movements of the membrane are five times increased in amplitude, while the extreme lightness of the lever reduces to a minimum the effects due to inertia. Examples of curves obtained by this method are shown in Fig. 10.

A very sensitive apparatus, termed the *Sprachzeichner*, has also been introduced by Hensen[2] for recording the delicate vibrations of a membrane. It will be readily understood by referring to Figs. 11, 12 and 13. Valuable observations have been made with the aid of this instrument by Wendeler,[3] on consonant sounds, by Martens,[4] on vowels and diphthongs, and by Pipping,[5] on vowels.

Such are some of the mechanical contrivances that have been devised for recording the movements of a membrane. None are free from error, however delicate they may seem to be, owing to the inertia of the parts, and consequently other arrangements were demanded. In 1862[6] Rudolph König introduced his well-known method of showing the movements of membranes by manometric flames. The apparatus is now so well known as to require no detailed description. Gas is led by a tube into a small capsule of wood, the cavity of which is divided by a thin membrane (Fig. 14, A). The gas passes into the right half of the cavity and escapes into a small burner, where it is lit. If sound waves are diverted by a small conical resonator into the left half of the capsule the membranous partition vibrates, there are alternations of compression and of rarefaction in the gas on the right side, and the flame is agitated, moving upwards and downwards with each vibration. The method of Wheatstone of dissociating the flames by a rotating mirror is then employed, and a sinuous ribbon is seen in the mirror. The ribbon is cut vertically into teeth, some larger, some smaller. The larger, less frequent, correspond to the

1 Donders: "Zur Klangfarbe der Vocale" (*Ann. der Physik und Chemie*, 1868).

2 Barlow: "On the Articulation of the Human Voice, as Illustrate by the Logograph" (*Trans.* Roy. Soc. 1876).

1 Société des Sciences Naturelles de Neuchâtel, 25 Avril et 20 Novembre, 1878.

2 Hensen: "Ueber der Schrift von Schallbewegungen" (*Zeits. für Biologie*, 1887).

3 Wendeler: "Ein Versuch über die Schallbewegungen einiger Konsonanten" (*Zeits. für Biologie*, 1886).

4 Martens: "Ueber des Verhalten von Vocalen und Diphtongen in Zesprochenen Worten" (*Zeits. für Biologie*, 1889).

5 Pipping: "Zur Klangfarbe der Gesungen Vocale" (*Zeits. für Biologie*, 1890); "Ueber die Theorie der Vocale" (*Arta Societatis Scientiarum Helsingfors*, 1894).

6 König: "Quelques Experiences d'Acoustique (Paris, 1882).

fundamental tone of the sound, the smaller to the harmonics that enter into the composition of the compound tone on which the quality of the vowel depends.

These flame pictures are only seen for an instant, and many efforts have been made to fix them by photographic methods. This was first attempted by Gerhardt[1] in 1877. He used the flame of cyanogen, and the somewhat poor result is shown in Fig. 16.

Doumer[2] obtained a brilliant flame by burning carburetted hydrogen in oxygen, and he also introduced into such researches a chronophotographic method by reproducing the images of a flame acted on by a tuning-fork of known pitch.

FIG. 3.—Changes of expression during speech. Chronophotography. Ten images per second.

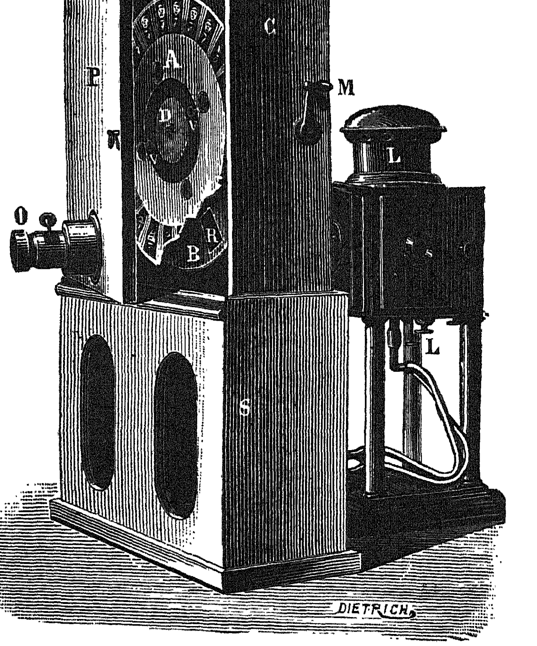

FIG. 4.—Photophone of Demeny. A, glass disc carrying the pictures; B, another disc, perforated; L, electric lamp; O, lens.

[1] Stein: "Die Licht im Dienste wissenschaftlicher Forschung." (Leipsig, 1877).
[2] Doumer: *C.R.* de l'Académie des Sciences, 1886.

Marage,[1] to whose researches we shall afterwards refer, feeds the capsule with acetylene, and thus obtains a luminous flame. The result of such an arrangement is shown in Fig. 17.

It will be observed that all manometric flames seen in a rotating mirror are inclined, as their composition is due to a horizontal and vertical translation, and the faster the mirror is rotated the more they are inclined.

Efforts have also been made to analyse sounds by photographing a ray of light reflected from a vibrating mirror. Long ago, but without photography, Czermak applied this method to the phenomenon of the pulse, and in 1879 Blake[2] devised a mirror for thus recording speech. He used a small metallic plate, in the centre of which was a small hook which is attached to a very light mirror delicately swung on two pivots, *c*, *c*, Fig. 18.

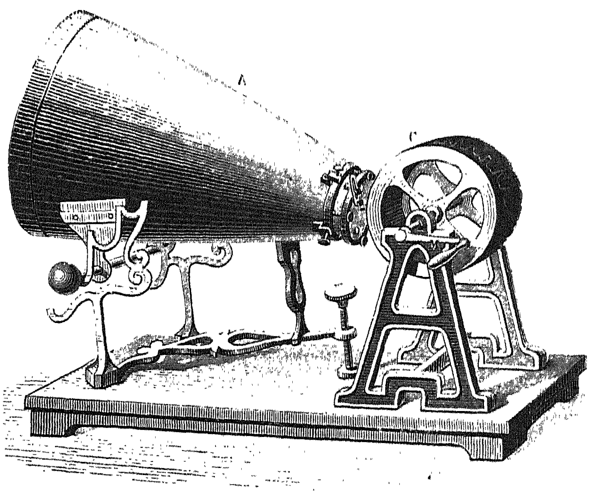

FIG. 5.—Phonautograph of Leon Scott. A paraboloid resonator, closed at one end by a membrane, to which a light lever is attached. C is a drum covered with smoked paper on which the lever traces a curve. As C rotates, it moves from right to left.

A ray of light is thrown on the mirror by a convex lens; after reflection it again traverses a lens and falls on a photographic plate in movement. Sharp, well-defined images are thus obtained (Fig. 19).

[1] Marage: "Étude des Cornet Acoustiques par la Photographie des Flammes Manometriques de König" (1897).
[2] Blake: *American Journal of Science and Art*, 1878; *Journal de Physique*, 1879.

The amplitudes of the tracings thus obtained from the tones of the voice were 0^{m}, 025 (1 inch), while those of the mirror were only 0^{mm}, 125 (1/200th inch).

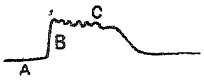

FIG. 6.—Tracings of the sound *b e*.

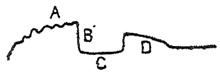

FIG. 7.—The sound *e b*.

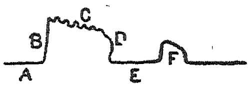

FIG. 8.—The sound *b e b*.

Rigollot and Chavanon,[1] in 1883, constructed a mirror-apparatus shown in Fig. 20, and Hermann,[2] in 1889, used a somewhat similar arrangement, the tracings of which are given in Fig. 21.

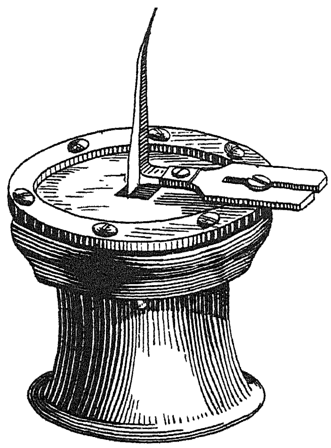

FIG. 9.—Arrangement of Schneebeli for recording movements of a membrane.

An ideal method for recording vibrations was devised by Rops in 1893, ideal inasmuch as it does not use any vibrating membrane or lever, or anything having inertia. A diagram is given in Fig. 22.

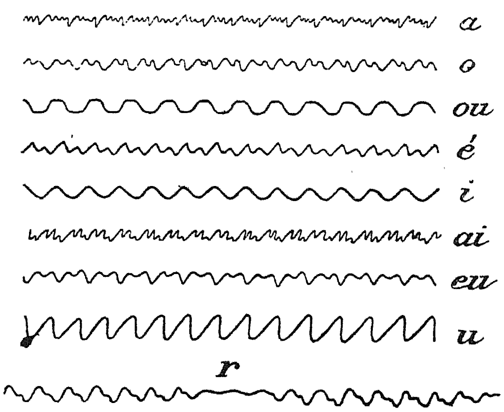

FIG. 10.—Curves of various vowels and of the consonant *r* recorded by the apparatus of Schneebeli.

It is based on the principle of photographing the effects of interferences of light waves. Rays from a luminous source A pass through the lenses *q q* so as to become parallel. They then pass through a slit *d* and a hole in a diaphragm *b*, and they are focussed by a lens *l* (of 15 centimetres focal length) so as to fall on a glass plate S_1. The ray divides into two, a_1 and a_2, and they run parallel, the ray a_1 passing through the air while a_2 passes along a tube *g* (15 centimetres in length), the ends of which are closed by the glass plates *h* and h_1. A few centimetres from the tube there is a resonator, *i*, into which the vowels are sung, thus causing condensations and rarefactions of the air,

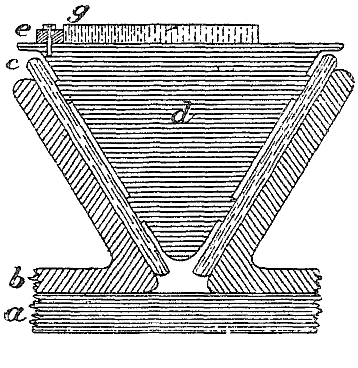

FIG. 11.—Apparatus of Hensen. *d*, Wooden prism; *c*, glass; *g*, smoked glass kept in its place by a screw clamp, *e*; *a*, *b*, supports.

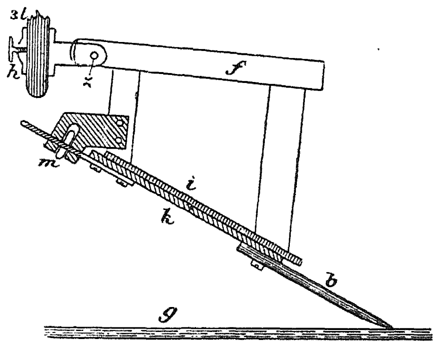

FIG. 12.—The recording portion of the Sprachzeichner of Hensen. *f*, *i*, frame having a joint, *z*; *b*, wooden point; *g*, smoked glass.

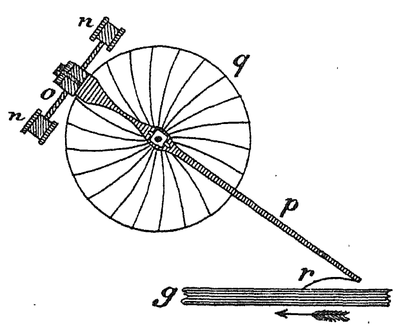

FIG. 13.—Writing portion of Hensen's apparatus. *n*, *n*, weights supporting an axis *o*, carrying marker *p*, with a point *r*; *q*, a disc communicating to the marker *p* the movements of the membrane; *g*, smoked glass plate.

disturbing the ray *h* h_1, while the ray passing through the tube *g* is unaffected. The two rays are again united by S_1; they then pass through an objective *c* and a lens *z* to a slit in a screen so as to fall on sensitive paper on the drum T. A diaphragm *b* cuts off secondary reflections. Thus beautiful images are formed corresponding to the vowels spoken or chanted into the resonator.

The invention of the tinfoil phonograph by Edison in 1877, and the improvement of the instrument by the labours of Edison,

[1] *Journal de Physique*, 1883.
[2] Hermann: *Pflüger's Archiv*, 1889.

Graham Bell and others in more recent years, has made it possible to investigate phonetic phenomena with the aid of this instrument. In 1878 Fleeming Jenkin and Ewing[1] devised a method of recording curves from the imprints on the tinfoil covering the drum of the phonograph, and these curves were submitted to harmonic analysis. This was also attempted by A. M. Mayer[2] in the same year. The subject was taken up by Hermann[3] about 1890, and he obtained valuable tracings by using the wax-cylinder phonograph. He succeeded in obtaining photographs of the curves on the wax cylinder, a beam of light reflected from a small mirror attached to the vibrating disc of the phonograph being allowed to fall on a sensitive plate while the phonograph was slowly travelling. In 1891 Boeke[4] measured with great accuracy the dimensions of the marks on the wax cylinder, and from these constructed the corresponding curves. This method has also been adopted by Marichelle.[5] McKendrick,[6] in 1895, photographed the marks on the wax cylinder of the phonograph, and in 1896 he devised a recorder for enlarging the curves on the well-known principle of the syphon recorder. In 1899 Scripture,[7] of Yale, investigated vowel-sounds with the aid of the gramophone. He transcribed, by an ingenious mechanical device, the marks on the gramophone disc into the forms of curves, and made a minute analysis. Lastly, Marage,[8] in a series of masterly papers, reinvestigated the whole subject of vowel-tones with the aid of a chronophotographic method and a special form of syren invented by himself.

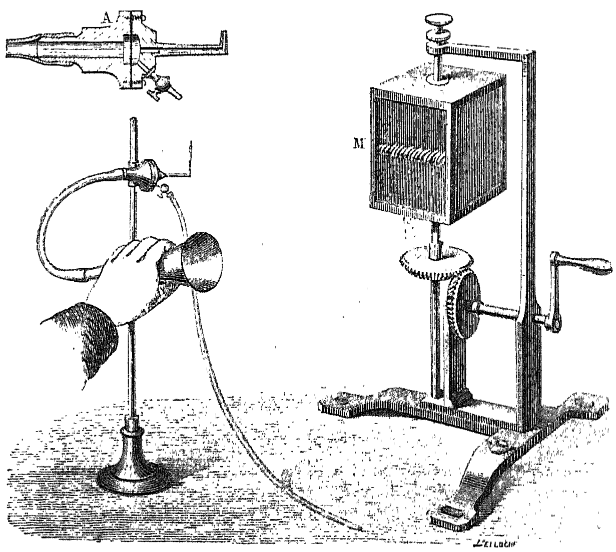

FIG. 14.—König's apparatus. A, Manometric capsule; M, rotating mirror.

The various experimental methods we have described have been chiefly directed to an examination of the nature of vowel-sounds. What is it that gives the peculiar quality to the sound of a vowel? How is it that we can, by the ear, identify the sound of any vowel, whether it be spoken or sung? How is it that if we sing a vowel on the notes of a scale we can still identify the vowel, whatever may be the pitch of the note on which it is sung? The scientific investigation of the nature of vowels begins with Willis,[1] who, in 1829, imitated the larynx by means of a reed, above which he placed a resonator, tuned to one of the harmonics of the reed. He also imitated vowel-tones by holding an elastic spring against the edge of a toothed wheel, and he placed the vowels in the following order—*ou*, *o*, *a*, *e* and *i*. In each case a compound tone was produced which retained the same pitch so long as the wheel revolved at the same rate. By keeping the wheel revolving at a uniform rate, and at the same time changing the length of the spring which was allowed to vibrate, Willis found that the qualities of various vowels were imitated with considerable distinctness. In 1837 Wheatstone,[2] in a criticism of Willis, made some important suggestions. In 1854 Grassmann[3] announced a theory as follows:—The vocal cords excite the resonances of the cavity of the mouth; the tonality changes with the degree of opening of the mouth by the development of some of the harmonics of the fundamental tone emitted by the larynx. According to this view, the buccal cavity adds by its resonance certain harmonics to the fundamental laryngeal sound. Grassmann classified

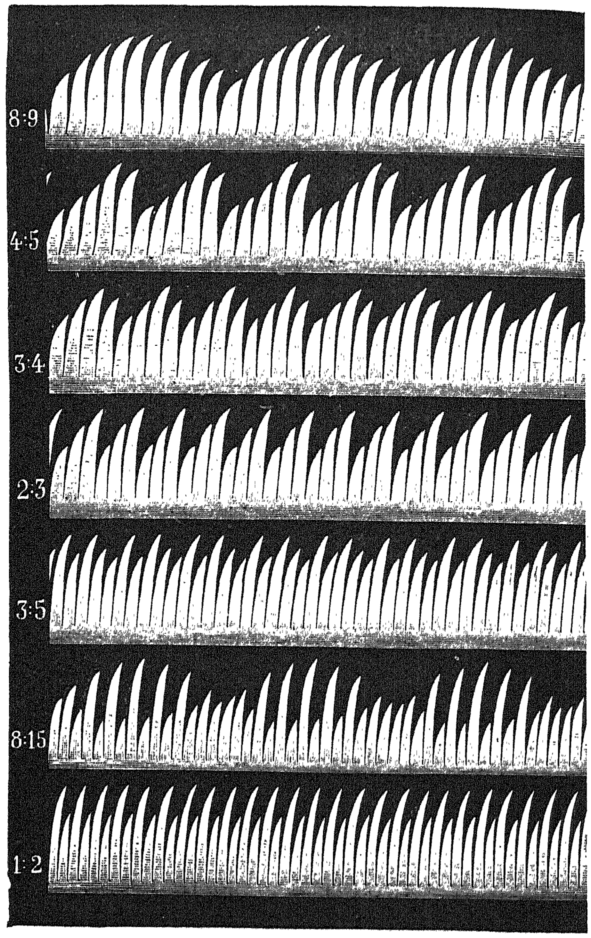

FIG. 15.—Examples of flame-pictures obtained by König's system of a manometric capsule adapted to two organ pipes. The figures to the left indicate the ratio of the vibrations of the two tones forming the compound tone.

1 Fleeming Jenkin and Ewing: "On the Harmonic Analysis of certain Vowel Sounds" (*Trans.* Roy. Soc. Edin., vol. xxviii. p. 745).
2 Mayer: *Journal de Physique*, 1878.
3 A full bibliographical reference to Hermann's papers is given in Schäfer's "Text-Book of Physiology," vol. ii. p. 1222.
4 Boeke: "Microscopische Phonogrammstudien" (*Archiv* f. d. ges. Physiol., Bonn, Bd. i. S. 297; also *Proc.* Roy. Soc. Edin., 1898.)
5 Marichelle: "La Parole d'après le Tracé du Phonographe" (1897).
6 McKendrick: *Trans.* Roy. Soc. Edin., vol. xxxviii. pt. iv.; *Proc.* Roy. Soc. Edin., 1896–97; also "Sound-Waves as Revealed by the Phonograph" (London, 1897.)
7 Scripture: "Studies from the Yale Psychological Laboratory" (1899.)
8 Marage: "Comment parlent les Phonographes"; "Les Exercises Acoustiques chez Les Sourds-Muets"; "Rôle de la chaîne des osselets dans l'Audition"; and "Théorie de la Formation des Voyelles" (from 1897 onwards).

1 Willis: Cambridge *Phil. Trans.*, 1829, vol. iii. p. 231: also *Ann. d. Phys. u. chem.*, Leipsig, Bd. xxiv. p. 397.
2 Wheatstone, *Westminster Review*, October 1837.
3 Grassmann, "Uber die physik. Natur der Sprachleute," 1877; he had, however, in 1854, enunciated his theory in "Uebersicht der Akustik u. der niedem Optik."

the vowels according to the number of harmonics which they contained, in the following table :—

$$a \begin{cases} o \text{ --- } ou \\ eu \text{ --- } u \\ e \text{ --- } i \end{cases}$$

In sounding *a* the mouth is widely opened and the fundamental and eight harmonics are produced; in the third series, on the contrary, there is only one harmonic sounded, which is more and more acute as we pronounce the vowels in the order *ou*, *u* and *i*. The vowels of the second series, *o*, *eu* and *e*, are transitional between the first and the third. Thus we pass from *a* to *ou* by *o*, from *a* to *u* by *eu*, and from *a* to *i* by *e*.

Donders[1] showed that the cavity of the mouth, as arranged for the giving forth of a vowel, was tuned as a resonator for a tone of a certain pitch, and that different pitches coresponded

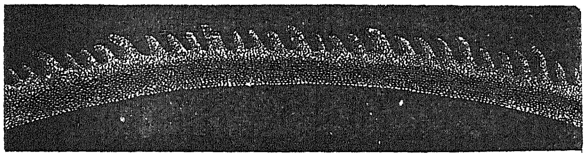

FIG. 16.—Vibrating flame of cyanogen photographed by Gerhardt.

to the forms of the cavity for the different vowels. This he discovered by the peculiar noise produced in the mouth when the different vowels are whispered. The cavity of the mouth is then blown like an organ-pipe and by its resonance reinforces the corresponding partials in the rushing wind-like noise. Then the question was taken up by Helmholtz.[2] He attacked it both by analysis and by synthesis. He analysed the vowel-tones by his well-known resonators, aided by his own singularly acute ear, and he attempted to combine, by means of tuning-forks, the tones which he thought existed in a vowel, so as to reproduce the sound of the vowel. In the latter part of the investigation he was by no means successful. These investigations led Helmholtz to put forward in succession two theories as to the formation of vowels. The first was that, as in all musical instruments, the quality or timbre of the vowel depends on the fundamental tone, reinforced by certain partials or overtones, of which a number are produced by the vocal cords along with the fundamental tone, the reinforcement depending on the resonance of the cavities above the vocal cords. This theory was upset by the use of the phonograph. If a vowel is sung to the phonograph while the cylinder is travelling at a certain speed, the vowel-tone will be reproduced with exactly the same quality if the cylinder is driven at the same speed, but if it is driven faster, then the quality of the vowel will be changed, so much so as to be scarcely recognisable. M. Marey narrates that Donders and he first made this observation when it so happened that the two savants were present in Paris at a public demonstration of the phonograph soon after its invention. Donders sang the vowel tones to the instrument, and then asked the operator to vary the speed of the cylinder during reproduction. Then the vowel *a* became *o*, and *e* became *ou*. Thus while the phonograph reproduces in a wonderful way the tones of musical instruments without change of quality, it cannot transpose vowel-tones without altering their character. This special character or quality cannot, then, depend on the overtones reinforced by the oral cavities being simple multiples of the fundamental tone, and Helmholtz's first theory had to be abandoned.

This led Helmholtz to advance a second theory as follows :— Each vowel is characterised by a certain harmonic or partial tone, of constant pitch, whatever may be the pitch of the note on which the vowel is sung or spoken. Attempts were then made, notably by Helmholtz and König, to fix the pitch of the characteristic partial tone or vocable, and there appeared to be

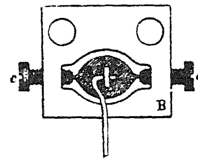

FIG. 18.—Blake's mirror

considerable differences in the results of the two distinguished observers, differences amounting to as much, in some cases, as three semi-tones.

The next step was, as has already been explained, to transcribe the marks on the wax cylinder of the phonograph, made on singing or speaking a vowel, into sinuous curves and to subject these to harmonic analysis. It is not difficult, in comparatively simple cases, to obtain a curve which is the algebraic sum of the ordinates of several sinusoidal curves, but it is not so easy to do the reverse operation, namely, to analyse the curves. Fleeming Jenkin and Ewing, afterwards Schneebeli, Hensen, Pipping and Hermann, have done this in accordance with the theorem of Fourier and the law of Ohm. In particular, Hermann, by a beautiful and ingenious method, has analysed the curves obtained by his photographic device, and has modified the theory of Helmholtz. His statement is that the oral cavity produces independently a harmonic or partial tone which has no definite relation to the fundamental tone emitted by the larynx. A vowel, according to him, is a special acoustic phenomenon, depending on the intermittent production of a special partial, or "formant," or "characteristique." The pitch of the "formant" may vary a little without altering the character of the vowel. For *a*, for example, the "formant" may vary from fa_4 to la_4, even in the same person. He has also attempted, but not with complete success, to reproduce the vowel-tones by synthesis.

There are thus three theories : (1) the first of Helmholtz, now abandoned, that the pitch of the partials is represented by simple multiples of the vibration periods of the fundamental; (2) the second of Helmholtz, that the pitch of the characteristic partial is always fixed, but has a definite relation to the pitch of the fundamental; and (3) that of Hermann, that the pitch

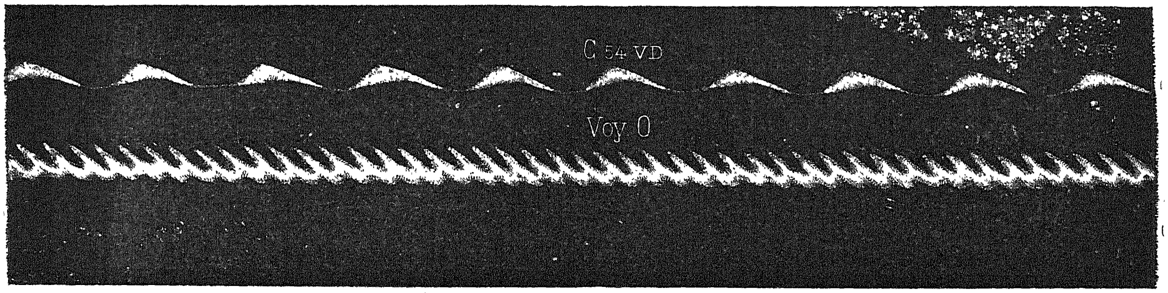

FIG. 17.—Photograph of manometric flames of acetylene showing vibrations of vowel o. Above are the images of chronographic flames—54 double vibrations per second.

[1] Donders : "De physiologie der Spraakklanken" (1870).
[2] Helmholtz : "Ueber de Vokale." *Archiv.* f. d. Holland. Beitr. 2, Nat. u. Heilk. (Utrecht, 1857). See other references given in Schäfer's "Text-Book," vol. ii. p. 1217 (footnote).

of the characteristic partial or "formant" is not absolutely fixed.

The difficulty of harmonising these theories has stimulated the zeal of many workers, and in particular Dr. Marage[1] has been remarkably successful in his researches into the nature of vowels. He first of all criticises the second theory of Helmholtz, pointing out that the failure to reproduce the vowels by synthesis is strongly against it. Thus while, by tuning-forks, the pitch of which is that of the partials of the fundamental tone, *ou*, *o* and *a* may be badly reproduced, it has been found impossible to reproduce E and I. He then objects to the theory of Hermann, namely, that the vowel is an oral intermittent and oscillating tone; first, that the method of recording the vowel on the wax cylinder of the phonograph causes grave errors, because the mouthpiece, tube, air chamber and vibrating disc all profoundly modify the vowel; second, that the method of analysis by Fourier's theorem assumes that the vowel curves are constituted by superposed simple curves, which is precisely the question at issue, and therefore the argument is a *petitio principii*; and third, that the data obtained by his method have

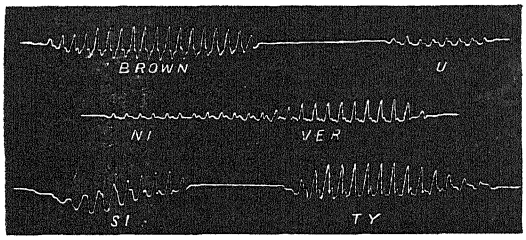

FIG. 19.—Photographic tracings obtained by Blake's method.

not enabled Hermann to reconstruct the vowels with greater success than Helmholtz. Marage then enters upon his own method, which consists essentially of using a special apparatus constructed on König's principle of manometric flames, but so

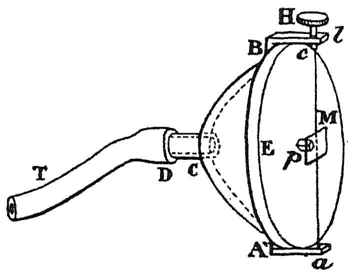

FIG. 20.—Palmoptic capsule of Rigollot and Chavanon (παλμικος, pertaining to vibrations). E F, collodion membrane; M, mirror carried by a wire *a c*, stretched between supports A and B, and regulated by the screw H; *p*, small cube of india-rubber resting on centre of membrane; T, tube.

simple as to be practically free from sources of error; that is to say, there is no mouthpiece, tube or lever. The pictures of the flames were produced photographically by feeding the flame with acetylene gas, and chronophotometrical records were taken with each experiment. He then finds that the flame pictures of I, U and OU show *one* flame, E, EU and O two flames, and A three flames. So that the classification of the vowels by flames is exactly that of Grassmann. Each vowel, when all errors have thus been got rid of by simplifying the apparatus, always gives the same picture for any given note. The picture is that of a continuous periodic curve, and the number of periods in a second corresponds to the laryngeal note, while the *form* of the period characterises the vowel. With the same vowel the period changes with the note. When the note is near the pitch of ordinary speech, the period varies very little. This is not so when the vowel is sung; the period then disappears until there is only the laryngeal note. Marage has also by synthesis reproduced the vowels with remarkable success. His first experiments with resonators were not quite satisfactory; he could reproduce OU, O and A, but not E and I. He ascertained, however, that to reproduce A the resonator must be tuned to the third harmonic or partial of the note on which A was sung; that to reproduce E, EU and O the best result was obtained when the resonator

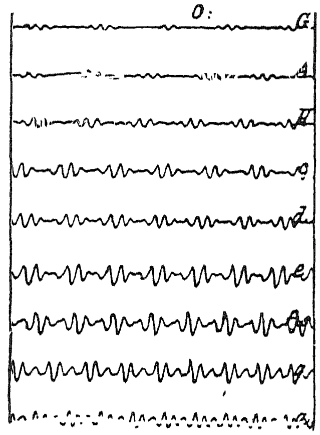

FIG. 21.—Tracings obtained by Hermann of vowel O.

gave the second partial; and I, U and OU were imitated (but not successfully) when the resonator was in unison with the laryngeal tone.

Marage finally devised a syren rotated by an electric motor and consisting of a disc having in it a triangular window representing the glottis. The air is driven under pressure through this aperture and then falls on another disc having windows cut out of it in groups according to the nature of the vowel to be synthetically reproduced. Thus the disc for A has four groups, each group consisting of three triangular slit-like windows; for O and E the disc shows five groups, each consisting of two slits; and for I and OU there are many slits, without these being arranged in groups. The slits are very large for O and narrow for E, and large for OU and narrow for I. He then moulded a series of casts of the interior of the oral and pharyngeal cavities of a human subject, as these were adapted for the singing of the different vowels, and from them constructed masks or head-pieces which could be placed over the syren so that the air escaping from it passed through the cavities of the mask. He found that if air was driven through the masks under a pressure of only 7 centimetres of water, the timbre of the corresponding vowel was at once perceived, as in whispering. Marage's view is that to form a vowel the true vocal cords vibrate in a horizontal plane, in such a way as to influence by their greater or less degree of approximation the escape of air.

If the air escapes in three little puffs as it were (the cords vibrating during each puff a number of times equal to the pitch of the note on which the vowel is spoken or sung), so that

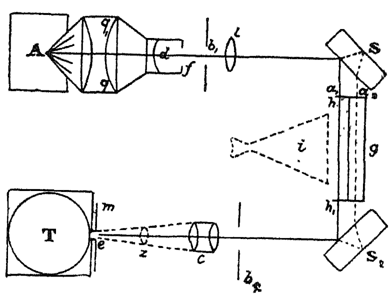

FIG. 22.—Rops' apparatus for the analysis of vowel-tones.

there are intervals between the groups of puffs, then the vowel A is the result. The oral resonator is in unison with the sum of the vibrations and the vowel is emitted. If the resonator (either artificial or the oral cavity, as in life) is turned to the

[1] Marage: "Théorie de la Formation des Voyelles," *op. cit.*

third harmonic of this note, then the vowel A is modified; the same applies to E and O, which have the second harmonic, and in passing from the one vowel to the other it is sufficient to change the aperture of the glottic opening. Thus for A, if the fundamental note is n, the oral resonator must be tuned to $3n$; for E and O, if the fundamental is n', the oral resonator gives $2n'$; and for I and OU the resonator is in unison. If this is not so, then the quality of the vowel is much altered. Thus if the syren gives A, and the plate used is that for OU, then the sound is A modified. This agrees with the experience of teachers of singing, who hold that a badly sung vowel is a vowel-sound emitted into a cavity adjusted for another vowel. Marage has also found that when the sounds of his syren, aided by the masks, are examined by the manometric method, the flame pictures appear as they may be expected to do, that is, groups of three flames for A, of two for E, EU, and O, and of one for I, U and OU. Vowels then, according to him, are due to an intermittent aëro-laryngeal vibration, strengthened by the oral cavity and producing OU, O, A, E and I, when it is in unison with the sum of the vibrations; transformed by it, and giving origin to other vowels, when there is no unison; and the number of intermittences gives the fundamental note on which the vowel is emitted. If the oral cavity acts alone, the vowel is whispered; if the larynx acts alone, the vowel is sung; and if the two act the vowel is spoken. Marage has applied his method with much success in testing the ear and in the treatment of mutes who are not absolutely deaf. His memoir is characterised by great simplicity and at the same time by thoroughness.

But the study of vowels is not the only result of recent research in phonetics. The analysis of consonantal sounds is now being carried out by various workers, such as Pipping, Scripture and Lloyd. Meyer, in Hermann's laboratory, has investigated the pitch of words, sentences and syllables in speech. This has also been studied by phonographic tracings by Marichelle. The whole subject has also a practical bearing, as the knowledge acquired enables the teacher of deaf mutes so to instruct his pupils in the use of their organs as to avoid the dreary monotone of those who learn to speak by watching only the movements of the lips.

It only remains to notice the remarkable monograph of Jespersen. This is an attempt to aid the study of phonetics by the use of a scientific nomenclature to express sounds, so that just as the chemist represents by letters and figures the nature of a chemical substance of complex constitution, so the student of phonetics may be able to express the sounds of words by symbols. The visible-speech system of Melville-Bell consisted of symbols which expressed more or less accurately the physiological movements to be made, or the position to be assumed, during the pronunciation of a given sound; but the symbols of Jespersen are letters and figures. The letters or figures, however, to be useful must have a physiological meaning. Strictly speaking the symbols denote, not sounds, but the elements of sounds. Thus so simple a sound as *m* is physiologically the result of (*a*) lips shut; (*b*) point of tongue resting in the bottom of the mouth; (*c*) surface of tongue not raised towards the palate; (*d*) nasal passage open; (*e*) vocal cords vibrate; and (*f*) air expelled from lungs. The attempt of Jespersen may be called an analphabetic system of writing, symbolising, not sounds, but the elements of sounds. At present it is severely technical, but it seems to "provide a means of writing down and describing phonetic minutiæ in a comparatively easy and unambiguous manner." It will do for the phonetician what symbolism does for the mineralogist. It is a kind of algebra for speech sounds.

In advocating the establishment of a photographic museum, to be a visual register of the past, Janssen recently wrote as follows:—"Photography registers the chain of phenomena during time, just as writing registers the thoughts of men during the ages. Photography is to sight what writing is to thought. If there is any difference, it is to the advantage of photography. Writing is subject to conventionalities from which photography is free; writing employs a particular language, while photography speaks the universal language."

But if there is to be a museum of photographs, appealing to the sense of sight, why should we not have a museum of sounds, in the shape of phonograph records, appealing to the sense of hearing? How little can we tell from written characters the exact sounds of ancient Sanskrit, or how Demosthenes spoke in Greek or Cicero in Latin? Would it not now be interesting to hear the exact accent of old English, or the Scotch of the fifteenth century? All dialects should be carefully registered and put aside for future consultation, and thus we would do for the ear what we do for the eye. No doubt such a collection of phonographic records would help onwards the science of language.

THE ANCIENT GLACIERS OF SKYE.

In the central portion of Skye there is a group of mountains unequalled elsewhere in Britain for rugged grandeur. To the south and south-west lie the Cuillin Hills, the serrated peaks of which rise to an elevation of more than 3000 feet; they are built essentially of a great laccolitic mass of gabbro, traversed by countless dykes and sheets of basalt. To the north lie the Red Hills, the smoother outlines and often ruddy aspect of which contrast markedly with the dark and rough elevations of Blath-bheinn, or Blaven, and the Cuillins; they are composed of granite and granophyre, and rise to heights rarely exceeding 2500 feet.

That the whole of this mountain district has been severely glaciated has for many years been recognised, but the detailed history of the ice-erosion has not hitherto been worked out. Mr. Alfred Harker, in the course of a special survey of the region, has had opportunities of study which have enabled him to write an essay on the subject which for completeness and lucidity is probably unsurpassed.[1] The district, as he points out, is one which had for long been subject to erosion; the drainage system in pre-Glacial times was a fully matured one, and the features then stood out in bold relief. Moreover, the amount of post-Glacial erosion has been so trifling that the effects of ice- and frost-action remain practically without modification by later agencies.

Mr. Harker tells how during the period of maximum glaciation the Skye mountains supported a true ice-cap, under which they were wholly buried, and this ice-cap was sufficiently powerful to withstand and divert northwards and southwards great portions of the ice-sheet from the Scottish mainland. He sees evidence of the movements of the lower layers of ice in the striæ on the rock-surfaces and in the dispersal of boulders; the upper layers not improbably took a course less restricted by the form of the ground. He describes the way in which the ice must have been forced into hollows and openings; its action in grinding down and tearing away rocks, irrespective of their mineralogical composition or structure; and its mode of widening and deepening valleys. Attention is drawn to the formation of cirques or corries, due consideration being given to their aspect and relation to the amount of sunshine. The erosion by ice-action of rock-basins, such as those occupied by Loch Coruisk and other lochs and tarns, is clearly stated and is one of the most effective arguments lately published on the subject.

Mr. Harker's observations lead to the conclusion that the principal glaciation was followed by a later and minor period of ice-action, when glaciers occupied the valleys, and, as would be expected, it is not always possible to discriminate between the work done by the greater and lesser agents. The movement of the later ice was, however, very different on many parts of the lower ground from that during the principal glaciation, a difference due to the withdrawal of the Scottish ice-sheet. To the later glaciation are attributed the perched blocks which occur on the bare slopes of some of the Cuillin valleys. That the higher ridges and summits of the ranges show little or no effects of glaciation is due to the fact that they acted as ice-sheds, and escaped erosion owing to the lack of rock-débris in the ice overlying them.

The mountains, as pointed out by Mr. Harker, are for the most part of bare rock, so also are the higher corries, except where encumbered with screes; while in the lower corries and main valleys the drift is never so thick as to obscure the true form of the ground. Hence the story of the ice-erosion is very plainly engraved on the land, while the author's intimate knowledge of the petrology has enabled him to track the courses of many boulders of peculiar mineral composition with absolute certainty.

1 "Ice-Erosion in the Cuillin Hills of Skye." By Alfred Harker, M.A., F.G.S. *Trans.* Roy. Soc. Edin., vol. xl. part ii., 1901.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

THE annual meeting of the Association of Technical Institutions will be held at the Skinners' Hall, London, on Friday, January 31, 1902. The Right Hon. Sir William Hart Dyke, M.P., will be in the chair, and an address will be delivered by the president-elect, Lord Avebury.

MR. WALTER PALMER, M.P,, has offered the University of London the sum of 2000*l.* to provide the apparatus required for the proposed post-graduate courses of lectures in physiology. A committee has been appointed to consider the details of the scheme.

THE system of secondary education in Italy forms the subject of criticism at the hands of Prof. Amati Amato, writing in the Lombardy *Rendiconti*, xxxiv. 17. The author regrets that from 1894 to the present time statistical data are very meagre, and it is desirable that a volume should be annually issued showing the number of schools of different grades and their total attendances. The data available for the period up to 1894 are more detailed, and show a marked increase in schools under clerical control and a decrease in those under lay management, and reasons are given for believing that the tendency continues to be in the same direction.

A DEPUTATION representing a number of University colleges waited on the Chancellor of the Exchequer on Friday last in order to place before him reasons why the annual Government grant to these institutions should be increased. In connection with this subject the facts given on p. 175 of this issue are of interest. The grounds upon which the application was made were summarised as follows :—The grant was originally placed upon the Estimates in the year 1889-90, the total amount being 15,000*l.*, apportioned among eleven colleges. An additional grant of 500*l.* was subsequently made to University College, Dundee. In 1897 the grant was increased to 25,000*l.*, which was distributed among twelve colleges. Since then the work of the University colleges has grown in importance and magnitude. New departments have been created, and probably in all the colleges important additions have been made to the teaching staff, together with a largely increased provision of appliances and equipment. In the year 1892 a Treasury committee reported in favour of a total grant of 30,000*l.* being made to the University colleges, a sum in excess by 5000*l.* of that which is at the present time distributed among them. In 1897 new colleges at Reading and Exeter were inspected by a Treasury committee appointed to visit University colleges, and declared at that time not to have reached such a standard in University work as to justify a claim upon a share in the grant. These colleges, together with another, have been again visited by a similar committee, and if by this time they are reported to have reached a standard which justifies their claim to be treated as fully equipped colleges in arts and science some decrease in the grants to other colleges would have to be made unless the total of 25,000*l.* is increased. Replying to the deputation, the Chancellor of the Exchequer said that there was no liability on the part of the Exchequer for University education in England, and declared that this was a doctrine which had always been accepted by Governments and by Parliament. The grant made in 1892 was a purely temporary measure, and did not imply any assumption of liability on the part of the Exchequer. It was only to be regarded as an attempt to aid local effort in places in which there was a strong desire for University education. The experience of the last five years had shown that the grant had had the effect of stimulating local effort. He would carefully consider the whole question; but, while he must decline to pledge himself to any increase of the present grant, he would do his best to prevent any loss falling on the colleges which were now in receipt of it by the admission of new colleges to its benefits.

SCIENTIFIC SERIAL.

American Journal of Science, December.—The geology of the Little Colorado Valley, by Lester F. Ward. The paper is accompanied by a section showing 3500 feet of Trias, of which 1200 are Painted Desert beds, 1600 Shinarump beds, and 700 Moencopie beds.—On pyrite and marcasite, by H. N. Stokes. It is pointed out that although there is no difficulty in distinguishing these two minerals in well-crystallised specimens, there remains a residuum consisting of massive or finely grained material in which this is not possible. The methods which have been proposed for such cases are criticised and found to be insufficient. A method has therefore been developed in which advantage is taken of the difference between the two sulphides in their behaviour towards solutions of ferric ammonia alum, and it has been found possible to apply this to determine the amount of each in mixtures. The application of this process to various samples of doubtful nature, especially of concretions, has shown that the finely fibrous specimens usually passing as marcasite are very commonly pyrite.—Studies of Eocene mammalia in the Marsh collection, Peabody Museum, by J. L. Wortman.—The dielectric constant of paraffin, W. G. Wormwell. Four samples of commercial paraffin were examined with a modified form of the Blondlot oscillator, the refractive index for the D line of the samples being also determined. The dielectric constant of a given paraffin increases with the density of the paraffin. It augments rapidly from a temperature 20° above the melting-point to a temperature 30° below the melting-point, and among different paraffins the dielectric constant increases with a rise in the melting-point. A comparison of the results for short electrical waves and short light waves shows that Cauchy's formula as a means of obtaining the index of refraction for indefinitely long waves does not meet the experimental data.—On some new mineral occurrences in Canada, by G. C. Hoffman.—The estimation of molybdic acid reduced by hydriodic acid, by F. A. Gooch and O. S. Pulman, jun. The conditions under which molybdic acid may be accurately determined by reduction with potassium iodide and hydrochloric acid are here laid down, and test analyses showing the accuracy of the method are cited.—The Veramin meteorite, by H. A. Ward. The meteorite consisted of an intimate mixture of metal and mineral, in roughly equal proportions. Analysis of the metallic portion is given.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, December 5.—"Notes on Quantitative Spectra of Beryllium." By Prof. W. N. Hartley, D.Sc., F.R.S.

In a quantitative examination made in 1885 of all the known methods of separating beryllium from aluminium and from iron the various precipitates obtained were dissolved and diluted to a known volume corresponding with the amount of bases in solution.

The solutions were spectrographically examined, and the photographs compared with others taken from solutions containing accurately weighed quantities of pure beryllia. Wave-lengths of lines shown by solutions containing 0·000001 per cent. of beryllium : 3322·3 extinct, 3130·3 nearly one-half the line still strong, 2649·8 reduced to a dot, 2493·6 a dot scarcely visible, 2478·1 a very fine short line.

The actual length of the line 2478·1, as rendered by solutions of 0·00001 per cent. and 0·000001 per cent. strength, is, in the former, 0·07, and, in the latter, 0·05 of an inch. The normal length of the line at this part of the spectrum is 0·22 of an inch. The quantity of substance yielding this spectrum is equivalent to one-millionth of a milligramme of beryllium. The coefficient of extinction of the two lines $\lambda\lambda$3130·3 and 2478·1 had not been reached by the dilution specified.

Beryllia has been separated from the alumina contained in felspar obtained from a granite found in co. Wicklow. From numerous experiments on the analytical processes employed in the separation of beryllia from alumina it was found that it remained combined with the sesquioxide bases in so persistent a manner as to lead to the belief that ordinary alumina might be found more often than not to contain traces of beryllia. Such, however, is not the case, though gallium has been ascertained to be present in almost all minerals which contain aluminium. As they belong to the same group, the two elements aluminium and gallium may be expected to form isomorphous mixtures, which would account for their being so constantly associated in nature; but the position of beryllium in the periodic system of classification shows that a similar behaviour with that element is scarcely probable.

Geological Society, December 4.—Mr. J. J. H. Teall, V.P.R.S., president, in the chair.—On a new genus belonging to the Leperditiadæ, from the Cambrian Shales of Malvern, by Prof. T. T. Groom. Forms referred to Beyrichia have long been known from the Cambrian beds of Scandinavia, Stockingford and South Wales, and the writer has obtained from the

lowest part of the Malvern black shales a species identical with the Stockingford form, which had been provisionally identified with the Swedish *Beyrichia Angelini*. The characters of these specimens serve to separate the species from those now placed under the genus Beyrichia, a conclusion in which Prof. T. Rupert Jones concurs.—The sequence of the Cambrian and associated beds of the Malvern Hills, by Prof. T. T. Groom, with an appendix on the Brachiopoda by Mr. C. A. Matley. The series, exclusive of some 600 feet of igneous rocks, may be estimated at between 2500 and 3000 feet, and consists of the following members, tabulated in descending order:—(4) The bronsil shales, 1000 feet thick; grey shales containing Dictyonema and many Tremadoc brachiopods and trilobites. (3) The white-leaved oak shales; black shales, including: (*b*) The zone of *Peltura scarabaeoides*, *Sphaerophthalmus alatus*, *Ctenopyge pecten*, *Ct. bisulcata* and *Agnostus trisectus*; 500 feet. (*a*) The zone containing *Kutorgina pusilla*, *Protospongia fenestrata*, a new variety of Acrotreta, and a new genus of the Leperditiadæ; 30 feet. (2) The hollybush sandstone, comprising: (*b*) Massive sandstone probably not less than 1000 feet thick, and containing *Kutorgina Phillipsi*, *Orthotheca fistula*, *Scolecoderma antiquissima*, and new species of Hyolithus. (*a*) Flaggy and shaly beds, not less than 75 feet thick; chiefly flaggy and shaly glauconitic sandstones, with *Kutorgina Phillipsi*, *Scolecoderma antiquissima*, *Hyolithus*, &c. (1) The Malvern quartzite, consisting chiefly of grey quartzites and conglomerates, rarely glauconitic; probably at least several hundred feet thick; containing *Kutorgina Phillipsi*, *Hyolithus primævus* and a new species of Obolella. Three new species of Hyolithus are named and described in full, and four in outline, while a revision of Holl's species *H. fistula* is given. Notes are also given, by Mr. Philip Lake and the author, on *Agnostus trisectus*, *Cheirurus Frederici* and other trilobites, and a name is given to certain cylindrical bodies which appear to be the eggs or excreta of some animal.

Entomological Society, December 6.—The Rev. Canon Fowler, president, in the chair.—Mr. J. H. Carpenter exhibited a number of *Colias hyale* bred from ova laid by the parent butterfly taken at Sheerness, August 18, 1900. Twelve months ago there was no trustworthy evidence as to how *C. hyale* passed the winter, but Mr. Carpenter discovered that it hibernates in the larval state and pupates and emerges in the spring. No one has yet successfully bred *C. edusa* through the winter, as they do not, and cannot, feed up these in this country. *Hyale*, on the other hand, is perfectly quiescent during the winter months, and nothing would induce the larvæ to feed at that period even when subjected to a temperature of between 60° and 70° F.—Mr. R. S. Standen exhibited specimens of *Lycaena dolus*, the type, from Bordighera, and also *Pieris brassicae* with greenish underwings, a common form in the neighbourhood of Florence.—Mr. C. P. Pickett exhibited pupa-cases of *Saturnia pavonia*, one with two openings, one with no openings, and a third containing three pupæ, from one only of which the imago had emerged. Mr. J. W. Tutt said that this phenomenon was not unusual in the case of silkworms, and commonly occurred also in the case of artificially bred *Lasiocampa lanestris*, being probably due to overcrowding.—The Rev. A. E. Eaton exhibited specimens of *Psychodidae* of morphological interest, preserved in corked tubes.—Mr. H. St. J. Donisthorpe read a paper entitled "The Life-History of Clythra 4-punctata," and Mr. G. Kirkaldy communicated "A Memoir upon the Rhynchotal Family Capsidæ."

Royal Meteorological Society, December 18.—Mr. W. H. Dines, president, in the chair.—The Hon. Rollo Russell read a paper entitled "Further Observations and Conclusions in relation to Atmospheric Transparency." For a number of years past he had made daily observations on the clearness of the atmosphere at Haslemere, Surrey, and in the paper he gave the results of the same. The principal conclusions derived from these observations are:—Haze and fog are commonly caused by the mixture of currents at different temperatures. These currents may be local or general, high or low. Thick haze or fog not dependent on different currents is rare, but differing currents frequently come into contact without producing haze or fog, and fairly clear weather under opposite currents is not uncommon. A fog may generally be taken *ipso facto* as evidence of the existence in the neighbourhood of a conflict of currents, and prevalent fog or haze commonly signifies that a different wind exists at a high level from that on the surface or at a slight elevation. The production of fog or haze by mixing currents depends chiefly on differences in their temperature. Broadly-extended westerly winds, with westerly upper currents, are the clearest, and visibility may reach the highest figures during their prevalence, whether they are dry or nearly saturated. Easterly and north winds are the most hazy, owing to the ordinary upper current from the west being seldom displaced by them, and to the mixture of these masses of air of different temperatures. When, as an exception, east and north winds are clear, it may be presumed, without direct evidence, that the upper current coincides with them in direction. In winter, therefore, unusual clearness in these winds often signifies a long spell of frost.—The other papers read were: Remarkable phosphorescent phenomenon observed in the Persian Gulf, April 4 and 9, 1901, by Mr. W. S. Hoseason; and the mechanical principle of atmospheric circulation, by Capt. R. A. Edwin, R.N.

Mathematical Society, December 12.—Major MacMahon, R.A., F.R.S., in the chair.—Prof. Love, F.R.S. (hon. sec.) communicated a paper by Mr. J. H. Michell on the flexure of a circular plate. Prof. Lamb, F.R.S., also spoke on the subject of the paper.—Lieut.-Col. Cunningham, R.E., gave a short sketch of Euler's method of finding "amicable" numbers and announced the discovery of two new primes A, B; where $A = f.a$, $B = f.b.b^1$. Then, in one pair, $(A, B) f = 3^4.7.11^2.19$; in the other pair (A, B) $f = 3^5.7^2.13.19$. In both pairs $a = 8747$, $b.b^1 = 53{\cdot}161$.

CAMBRIDGE.

Philosophical Society, November 25.—Dr. J. Larmor, vice-president, in the chair.—The negative radiation from hot platinum, by Mr. O. W. Richardson. The radiation was investigated experimentally chiefly by measuring its variation with the temperature of the metal. The radiating surface was that of a fine platinum wire heated by a steady current. The saturation current from the wire to a surrounding cylinder was measured by means of a sensitive Thomson galvanometer through which the cylinder was put to earth. The pressure in the apparatus varied from ·008 to ·16 mm. The temperature of the wire was obtained by determining its resistance. It was shown that there was no sensible current when the wire was charged positively; with a negative charge on the wire the current rose to as much as 4×10^{-4} amperes at 1600° C. The results are shown to be consistent with the theory that the effect is due to corpuscles escaping from the metal.—On the ions produced by an incandescent platinum, by Prof. J. J. Thomson. The incandescent metal in these experiments was at a temperature between a dull red and a bright yellow heat. At these temperatures only positive ions are produced in the neighbourhood of the wire. Curves showing the relation between the current and the potential difference were obtained; these curves show three well-marked stages. In the first stage the current increases more rapidly than the potential difference. In the second stage the rate of increase of the current diminishes rapidly, the current becoming towards the end of the stage independent of the difference of potential; this at low pressures is followed by a third stage in which the current again increases rapidly, indicating the formation of fresh ions. The currents when the potential difference was increasing differed frequently from those for the corresponding potential when decreasing—the curves often indicating a kind of hysteresis. The saturation current between a hot and a cold platinum plate was found to be independent of the distance between the plates. The masses of the positive ions were determined by the method previously used by the author to determine the masses of the negative ions arising from ultra-violet light or metals at a white heat; it was found that the carriers of electricity were not all of the same kind; the mass of the smallest of these had a mass of the same order as that of a molecule of oxygen.—On the action of incandescent metals in producing electric conductivity in gases, by Mr. J. A. McClelland.—On the seminvariants of systems of binary quantics, the order of each quantic being infinite, by Major P. A. MacMahon.—On the zeros of polynomials, by Mr. J. H. Grace.—The type-specimens of *Lyginodendron oldhamium*, Binney, by E. A. N. Arber.

EDINBURGH.

Royal Society, December 2.—Lord Kelvin, president, in the chair.—The president read an obituary notice of Prof. Tait, which contained interesting reminiscences of their work together when they were preparing "Thomson and Tait."—Dr. Halm, in the second part of his paper, on the state of equilibrium of

stellar atmospheres, gave further illustrations, from the conditions holding in our own atmosphere, of the distinction between thermostatic equilibrium and convective equilibrium, the former being characteristic of the upper strata and the latter of the lower strata, especially in the neighbourhood of mountains. Passing to the case of the sun, he found it necessary to assume (in order to explain the *height* of the chromosphere) that hydrogen gas contains an appreciable amount of potential energy, latent heat, as it were, stored up by the dissociation of its molecules into smaller molecular groups. A comparison of the deviations from Dulong and Petit's well-known law led to a division of the elements into two groups, of which iron and carbon might be taken as the types. In the one group the molecular potential energy increases with the temperature, in the other it diminishes. Hydrogen belongs to the former group. These considerations also gave a clue to the comparative smallness of the layer of metallic vapours in the sun, and, moreover, explained why the spectra of the hottest stars were characterised by a broadening of the hydrogen lines and a narrowing of the lines of the metallic vapours. Finally, it was shown how a change of temperature in part of the sun's photosphere would, on the principles developed in the paper, at once cause violent outbursts of hydrogen gas, such as are observed in the solar protuberances.—Lord Kelvin exhibited a model of the diatomic equilateral crystalline assemblage described in his paper on molecular constitution of matter, Roy. Soc. Edin., July, 1889. By means of this model any relation between the rigidity and the resistance to compression could be obtained, thereby completely disposing of the reasoning of the older French elasticians, who believed that there must be a definite relation between the two elastic constants in an isotropic elastic solid.

DUBLIN.

Royal Irish Academy, December 9.—Prof. R. Atkinson, president, in the chair.—Prof. J. P. O'Reilly read a paper on the waste of the coast of Ireland. In this paper the author discussed the different stages of change that the country had gone through following the work of Prof. Boyd Dawkins, "Early Man in Britain and his Place in the Tertiary Period." Taking the state of the country at the end of the Pleistocene period, when the great forests covered the surface of the upraised drift surface, he pointed out how this has been taken to indicate the then existence of land extending off to the west either as a continental plateau or as a series of islands which sheltered this forest growth, now impossible owing to the harsh winds which come in directly from the ocean. He directed attention to the report of Messrs. Newton and Teall, referred to in NATURE, vol. lvii. p. 324, on the lava sheets of Franz Josef Land, which tends to admit the former existence of an immense basaltic plateau of which the islands Spitsbergen, Jan Mayen, Iceland, Greenland, the Faroes, Hebrides and N. Ireland formed part, the subsequent break-up of this plateau giving rise to islands and to the present state of those mentioned. Explaining how meagre the details are concerning the changes undergone by the coast of Ireland in past times, he pointed out how these might be supplemented by examining what the coasts of the northern islands, Scotland, Cornwall and of France had suffered in loss from the continual beat and wear of the Atlantic storms and waves. The loss and waste he showed to be far greater than is generally imagined, and that Ireland and the islands which once bordered it to the west, south-west and north-west must have undergone, and be actually suffering, very great and serious waste and change. Considering the great scientific importance of the question, it was submitted that it would be becoming on the part of the Royal Irish Academy to promote a survey of the coast line as it actually stands at this commencement of the twentieth century, and to have points fixed as has been done for the coast of Scandinavia, so that hereafter it may be possible accurately to fix the rate at which the island is being wasted away by the Atlantic waves, and in this manner to allow of a determination being made of what was its former extent in prehistoric and early historic times.—Prof. Charles J. Joly read a paper on the point representations of screws. The reciprocal of the quadric in six variables representing screws of a given pitch plus p, taken with respect to the quadric of zero pitch, is shown to be the quadric of pitch minus p. From this property the remarkable relations detailed by Sir Robert Ball in his recent memoir, "Further Developments of the Geometrical Theory of Six Screws," are easily deducible. In the second part of the paper a method is explained of representing a screw by a pair of weighted points in a given plane—the five numbers required consisting of the ratio of the weights and the two coordinates of each point of the pair.

NEW SOUTH WALES.

Royal Society, October 3.—Prof. Liversidge, F.R.S., president, in the chair.—Marriage and descent among the Australian aborigines, by R. H. Mathews. In this short paper the author dealt with the social laws of some tribes in New South Wales, Queensland and elsewhere. Tables and genealogies were supplied illustrating the marriage restrictions, and the descent of the resulting progeny. A brief description was given of certain inaugural ceremonies through which the youths have to graduate in order to reach the status of aboriginal manhood.—On the constituent of peppermint odour occurring in many Eucalyptus oils—part i., by Henry G. Smith. The first Eucalyptus oil was distilled by Dr. White in 1788, at Sydney, and owing to the great resemblance between this oil and that obtained from the peppermint *Mentha piperita*, he named the tree from which he had obtained the oil the "Peppermint Tree." Its botanical name is *Eucalyptus piperita*. Since then many other species of Eucalyptus have been found to have this peppermint odour, and are generally known as "peppermints." The constituent giving this odour has now been isolated. It occurs in greatest amount in the oil obtained from the leaves of *E. dives*, next in that of *E. radiata*, and in fair amount in the oils of several other species. It is usually found in those Eucalyptus oils in which the principal terpene is phellandrene, although this is not always so, but generally there is an almost entire absence of Eucalyptol in those oils in which it occurs most abundantly. The crude oil of *E. dives* was taken for the preparation of this peppermint constituent. This constituent is not menthone, and is probably a new ketone; a molecular determination gave 155, so that probably its formula may eventually be found to be $C_{10}H_{18}O$.—On the crystalline structure of gold nuggets from Klondyke, Victoria and New Zealand, by Prof. Liversidge, F.R.S. Sections of three nuggets from Klondyke were shown. The crystal faces are comparatively small, and the nuggets have a granular structure, as if built up of separate grains, of one or two millimetres in diameter. They are also more fissured and contain more cavities than usual. The sections of Victorian (Australian) and New Zealand nuggets are also made up of small crystals, and they present numerous small cavities after the removal of the quartz and iron oxide by treatment with hydrofluoric and hydrochloric acids, so that the sections present quite a different appearance from the very compact and largely crystallised nuggets from West Australia.

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THURSDAY, JANUARY 2, 1902.

THE PHYSIOLOGICAL EFFECTS OF ROUTE MARCHING.

Studien zu einer Physiologie des Marsches. By Dr. Zuntz, Professor of Physiology in the Royal Agricultural College, Berlin, and Dr. Schumburg, Oberstabsarzt 1st Cl. and Privatdocent, Hanover. (Vol. vi. of the *Bibliothek von Coler, Sammlung von Werken aus dem Bereiche der Militär-medicinischen Gebiete.* Edited by O. Scherning.) Pp. viii + 361, and one chart. (Berlin: August Hirschwald, 1901.)

THE "Bibliothek v. Coler" was commenced in March last to celebrate the seventieth anniversary of the birth of Generalstabsarzt Alwin v. Coler, who held the post of Director-General of the Army Medical Service in Germany from the year 1889 until his death in September last. V. Coler was intimately associated with the development of that service ever since its foundation in 1868, and it may truthfully be said that the fine *esprit de corps* which exists in it to-day, and which is characterised by a determination to maintain a high standard of culture and scientific attainment amongst its members, is due to his influence. The collection of works which have been called after him admirably demonstrates what this influence meant. It is edited by Generalarzt Otto Scherning, v. Coler's colleague and ally, and some twenty-six volumes are already announced. They are an excellent expression of the scientific work of the German Military Medical Service, as carried out under v. Coler's guidance and inspiration, as well as of the intimate relationship that exists between army doctors and the teaching professors in Germany.

The authors of the volume under review are well known. Prof. Zuntz's previous work on metabolism is authoritative, and Dr. Schumburg has acquired a wide reputation for original investigations on a variety of military medical subjects. The volume is a record of careful and elaborate observations, made by them, on the physiological effects of route marching. In some of their experiments, notably those involving complicated chemical analyses, they were helped by Prof. Munk, Dr. Nichter, Dr. Frenzel and others.

The introductory chapter is an historical sketch of previous anatomical and physiological work in the same direction from the time of Fabricius de Aquapendente, Gassendi and Borelli to the more modern investigations of Marey, Vierordt, Braune and Fischer. This *résumé* is fairly complete and interesting, but the work done in England is not well represented.

The remaining chapters are an account of the authors' own observations and are of exceptional interest and merit. Five students of the Kaiser-Wilhelm-Academie (formerly known as the Friedrich-Wilhelms-Institut), the cadet school for medical students destined for the military medical service of their country, volunteered for the experiments. During April, May, June and July they marched, at frequent intervals, a distance of 24·75 km. without altering the route or the pace. The marches were commenced, as a rule, at 7 o'clock in the morning, occasionally at 5 o'clock, and two halts were made, one of ten minutes and the other of half an hour for breakfast. The service uniform and accoutrements were worn, and, with the exception of the weather, the only variation in the condition of the marches was in the weights carried. In fact, the experiments were conducted to determine the limit of weight which the soldier can carry without interference with his capacity for striking, and striking hard, at the end of a day's march. Both authors were members of a German War Office committee appointed to decide this point by physiological experiment in 1894, and, although the observations recorded in this volume were conducted during that year, they do not appear to have been made public until now.

It would be difficult in a short review to detail all the points of interest in the volume. They are many. Several of the more important scientific details are contained in tables interspersed throughout the text or brought together in appendices. If the headings of the columns of figures in these tables indicated more precisely what the figures represented, the physiologist would be able to study the records and draw his own conclusions from them without much difficulty. Unfortunately, this is not always the case, and it is often impossible to follow the tabulated records without closely reading the text; and, as is apt to be the case in German works of this kind, the latter is full of argument, comparisons and historical comments which tend to confuse the simple statements of fact. At the same time, it is only fair to say that these interpolations are well-balanced criticisms of the results of the experiments, and that the authors' conception of their own laborious work is dignified and modest in the extreme.

The extent of this work may be estimated from the fact that immediately before and after each march, sometimes during the march and on days of rest, careful examination was made of all the organs and functions of the body that were likely to be influenced by the carrying of a heavily loaded knapsack. This included sphygmographic tracings, enumeration of blood corpuscles, estimation of the specific gravity of the blood, experiments on the reaction of muscles and nerves, measurements of vital capacity and records of variations in urinary constituents. These formed one series of observations only. A second and more complicated series was carried out, in the case of two of the students only, in order to determine the effect of the marches on metabolism, and one must be content to present here a few of the practical results of these investigations without attempting to exemplify the full extent and scope of the work.

After graduated marches with lighter weights, the students were made to carry knapsacks with loads of 22, 27 and 31 kg., and the physiological effects of the lightest, intermediate and heaviest of these loads were compared.

The general condition of the students improved, excessive fat disappeared, while the body-weight was reduced by 1·5 to 3·5 kg. The sphygmographic tracings showed that cardiac systole was prolonged and diastole shortened as the weights carried were increased. This is exemplified by the use of a quotient derived from the formula $\frac{D}{S}$, where D represents the durations of the diastole and S that of the systole in

1/100ths of a second. The mean of the observations made this quotient = 1·73 with a 22 kg. load, 1·58 with 27 kg., and 1·47 with 31 kg., while the lowest quotient of $\frac{D}{S}$ recorded during rest was 1·88 and the highest 3·28. The effect of heavy marches on the systole and diastole of the heart was, therefore, as the authors express it, undoubted. They attribute the result to fatigue of the cardiac muscle and consider that, if the load is raised beyond 31 kg., permanent damage to the heart may result. They also noted that the pulse increased to 140 and 150 beats per minute and that dicrotism became marked as the quotient of $\frac{D}{S}$ approached unity.

Another important and unexpected result was that in a series of eighty-nine observations the cardiac area of dulness showed marked increase in sixty-four and the hepatic area in sixty-seven instances after the march. This increase was noted in 56 per cent. of the observations after a march with 22 kg., in 70·4 per cent. with 27 kg. and in 87·5 per cent. with 31 kg.

Still more important is the observation that the increase in the area of dulness was due to dilatation of the right and not of the left side of the heart, and that it is produced by a general stagnation of the venous circulation. The authors designate the phenomenon "march dilatation of the right side of the heart."

These observations on the cardiac function are new and well worth noting. They have special significance for the military medical officer, as they throw a new light on the condition known as "disordered action of the heart," which is a common sequel of military training and the cause of a considerable amount of invaliding in the British Army.

The observations on other organs and functions did not produce quite such interesting or positive results. The specific gravity of the blood was only increased by ·006 and the red blood corpuscles by 9 per cent. after the heaviest march. An apparent increase of 43 per cent. in the white corpuscles was due to polynuclear cells being carried into the circulation from the walls of the larger veins, in consequence of increased cardiac action; but the blood resumed its normal condition on the day following the march.

The vital capacity of the lungs was studied by means of an experimental gas meter, into which a number of expirations was made in succession, and the volume indicating vital capacity determined by dividing the total record by the number of expirations. This was considered more accurate than records given by Hutchinson's spirometer. Sixty-nine observations were made during marches with loads and eighty-nine during marches without loads. The practical result was that, up to a certain point, the graduated training of the soldier increased his vital capacity, but that a marked diminution occurred in marches with the heaviest loads, this serious result being associated with the dilatation of the heart and liver and the venous stagnation already noted. Another practical observation was that the increase in frequency of respiration, which is invariably associated with exercise, gradually falls to normal during halts, but that when dilatation of the right side of the heart had become well marked, this increase remained as high as 40 per cent. above the normal even after a halt of 30 minutes. The authors conclude that frequency of respiration exceeding 28 per minute, or 75 per cent. increase on the normal, with a gradual fall to 30 per cent. above normal after a quarter of an hour's halt, is the limit which can be borne by a soldier of average strength without breakdown.

The observations on the effect of the marches on body temperature are comparatively brief, but the subject of the regulation of heat and the calorific value of the work done forms a complicated series of calculations and experiments introduced into the chapters which are devoted to the study of metabolism. The authors estimate that the heat production of the work done in marching is sufficient to raise the body temperature 1° C. in 8·7 minutes. In the direct observations there was an actual increase of temperature of 1° to 1°·5 C. only, after the heaviest marches. As the surface cooling resulting from the evaporation of sensible and insensible perspiration plays so important a part in maintaining heat equilibrium, the authors rightly emphasise the importance of attention being paid to the material and nature of the soldiers' clothing with a view to avoiding interference with this function of the skin.

Experiments on the influence of the marches on the nervous system and on muscles were unsatisfactory. Observations were made on the "reaction period," and ergographic tracings were taken with Mosso's apparatus. The results in both cases were inconclusive and conflicting, weather, individual disposition, auto-suggestion, all helping to bring this about. An attempt was also made to estimate the effects of the marches on the nervous system by some ingenious memory tests, but they were so influenced by the drowsiness consequent on the early morning start that the after results were quite inconclusive.

Some interesting facts are recorded in connection with the renal function. Notwithstanding the great loss of water by perspiration, there was no increase in the specific gravity of the urine. Thus the average specific gravity in 150 observations before the march was 1023·6, and after the march 1021·7. This convinced the authors that marching has a diuretic effect, and they recall similar observations by Oertel and Henschen. Their observations on albumin in the urine are also contrary to the general impression, an impression no doubt derived from the observations of Albu and of Macfarlane, that during hard physical exercise transient albuminuria occurs. Zuntz and Schumburg found nothing of the kind amongst their five students, and they point out that Benedicenti had made similar observations on soldiers.

The series of observations and experiments on metabolism includes analysis of nitrogenous waste, respiratory changes, calorific value of the work performed, and the regulation of the body temperature. The observations are of an elaborate and complicated character, and only two of the five students were submitted to experiment. The chief practical results may be briefly noted.

The elimination of nitrogenous products both by the skin and kidneys was not markedly influenced by the marches. When increase did occur, it occurred on the day following the march, and not during or immediately

after the march. The calculation of elimination by the skin was made by careful analysis of the underclothing. The average amount was found to be 284 mg. per litre of perspiration, and as the perspiration increased the proportion of nitrogen eliminated diminished. Thus 2069 grms. of perspiration contained 0·308 per cent. of nitrogen, while 3447 grms. contained only 0·243 per cent. The number of observations on this point was few, and the results suggest the need of further investigation.

In estimating the respiratory changes, the authors made use of the "*tret-werk*," a rolling platform worked by machinery so as to move backwards at the same rate as the individual walking upon it moves forwards. In this manner he remains constantly at the spot where the apparatus for measuring the respired air is fixed. The two students marched on this "*tret-werk*" for six to eight minutes immediately after each march, and for eight to ten minutes during periods of rest, with and without the knapsack. The influence of the marches on the respiratory changes was determined by the "respiratory quotient," *i.e.* the quotient derived by dividing the volume of CO_2 expired by the volume of O inspired. This quotient is equal to unity in the case of herbivorous animals, who obtain their carbon from carbohydrates only and not from hydrocarbons. In carnivorous animals the necessity of using some of the oxygen for the oxidation of the hydrogen in the hydrocarbons, which they consume, diminishes the volume of CO_2 expired in proportion to the oxygen inspired, and the quotient in their case is consequently expressed by a fraction of unity. The authors make use of this fact and show that the "respiratory quotient" is a constantly diminishing fraction after heavy marches. In other words, the carbohydrates are very quickly used up, leaving the fats only as energy-producing material. They conclude from this that, in continuous heavy marching, the carbohydrates consumed in the rations are not sufficient to replace the waste, and that a day's rest is required after every three days' marching to enable the body to recover its normal power.

There are many other points in this volume that are suggestive and of practical importance in military training and in military operations, and it must be regarded as one of the most important works that have been published with reference to several questions that arise in connection with military hygiene. The German military authorities, at any rate, have accepted the conclusions as authoritative, and the regulations bearing upon marching and physical training in Germany are evidently inspired by them.

W. G. M.

LIVES OF THE HUNTED.

The Lives of the Hunted. By Ernest Seton-Thompson. Pp. 360. (London: Nutt, 1901.) Price 6*s*. net.

"LIVES OF THE HUNTED" is practically a second volume to the first of three books noticed in a general review of Mr. Seton-Thompson's work lately published in NATURE (p. 25), "Wild Animals I have Known." When a book has earned a well-deserved success, the temptation to the author to write another on the same lines is strong. But sequels of the kind are seldom as good as the originals, and this is no exception to the rule.

Mr. Thompson is so well up in his subjects that nothing that comes from his pen or pencil can be without interest. The full-page illustrations—more particularly those of the bears in the Yellowstone Park and the big-horn ram facing the wolves—are excellent; but, with some exceptions, neither the letterpress nor the marginal sketches are quite on the level either of the book named above or of the "Biography of a Grizzly."

Unfortunately, too, the little pitted speck noticeable in his earlier writings—more especially in "The Trail of the Sandhill Stag"—a tendency to a rather sickly sentimentality, has grown to disfiguring proportions, and in his last production is a serious blemish.

"The preservation of our wild creatures," to which the book is dedicated, is a worthy object. But it is doubtful whether it is likely to be substantially helped by suggestions, if not actual arguments, which, in spite of Mr. Thompson's assurance that he does "not champion any theory of diet," can only, if pushed to their logical conclusions, mean that mankind is in duty bound to give up eating meat and turn vegetarian. The sneer at "the Saxon understreak of brutish grit, of senseless, pig-dogged pertinacity," which made the old huntsman Scottie stick to the trail of the great ram until the coveted head and horns were his—the race-quality, by the bye, which has helped more, probably, than any other to raise the United States as well as England to the positions they hold among the nations—may appeal, perhaps, to some of his readers, but to others less emotional it may seem a little silly.

"Wolfish human brute" is rather a "brutal" summing-up of the character of the plucky old stalker, whose actual name is given, to come from the pen of a writer who, according to his own account, was not, in trapping days, foolishly over scrupulous.

But when he leaves "gush" and sentiment behind him, and, warming to his work, writes in the bright, unpretentious style which is more natural to him of the things he has seen and known, Mr. Thompson is well worth reading.

"Johnny Bear," the third story in the collection, is a simply-written and charming description of the ways of the bears he studied closely in the Yellowstone Park, and even more delightful, perhaps, is the account he gives of the home and habits of the fairy-like kangaroo rat,

> "the loveliest, daintiest fawn-brown little creature ever seen in fur," with "large beautiful eyes . . . innocent orbs of liquid brown; ears like the thinnest shells of the sea, showing the pink veins . . .; hands the tiniest of the tiny, pinky-white and rounded and dimpled like a baby's."

Sentiment notwithstanding, Mr. Thompson dug out and explored, and in the margin gives a plan of the little creatures' underground establishment, which was safely protected from the attacks of coyottes and other miscreants by the spiked leaves of an overshadowing "Spanish bayonette" bush. It is engineered on much the same general lines as the breeding nest of a mole, with

the addition of granaries for dried seeds—the different sorts kept separately—and with more blind passages. In place of the leaves with which a mole fills its more roughly constructed inner sanctuary, the kangaroo rat's nest was lined with "a thick felting of fine grass and weed silk, and, inside all, a lining of softest feathers." "I think," he writes, "that every gay little bird on the plains must have contributed one of its finest feathers to that nest."

Among the best passages in the book are those in which Mr. Thompson in his first chapter reads the records of the old ram's long life in the gravings of his horns. The deep dent tells of the early battle in which he won his spurs. The two dark-coloured, wrinkled rings close together lower down are reminders of the years of starvation and the sickness which carried off the weaker members of the flock, and the bolder ridges wide apart recall the prosperous years that followed.

He has much to tell that is worth learning, and, left to himself, can tell it excellently. It will be a misfortune to many lovers of natural history besides himself if Mr. Thompson is beguiled into sacrificing himself on the shrine of the admirers who, as he tells in his preface, "bitterly denounced" him for confessing that in unregenerate days he was not above killing a dangerous wolf when he could. T. D. P.

CUBIC AND QUARTIC CURVES.

An Elementary Treatise on Cubic and Quartic Curves. By A. B. Basset, F.R.S. Pp. xvi + 255. (Cambridge: Deighton, Bell and Co., 1901.) Price 10*s.* 6*d.*

NOW that Salmon's "Higher Plane Curves" is out of print there is undoubtedly room for a good book on the subject. The purpose of such a book would be to give students who had read conic sections and the infinitesimal calculus a good knowledge of the main lines on which the theory of curves has been developed. The bookwork would contain discussions of the chief theorems; those of less importance would be given as examples, and would furnish the student with abundant matter for independent thought. The proofs given would, so far as possible, be models of rigour and elegance, and in the rare cases where rigour was sacrificed for the sake of simplicity this would be confessed. The book before us has not been written altogether on these lines. There are no examples, and a great deal of space is taken up in proofs of the properties stated that could, in our opinion, have been put to better use; moreover, the proofs given are not always satisfactory, and even the theorems themselves are sometimes wrongly stated.

After two introductory chapters, chapter iii. deals with tangential coordinates, reciprocal polars and foci, chapter iv. with Plücker's equations. Then we have a chapter on "cubic curves" (pp. 56–73) and another on "special cubics" (pp. 74–96). The special curves discussed are circular cubics, and in particular some that are the inverses of conics, the semicubical and cubical parabolas, the folium of Descartes, the witch of Agnesi. Chapters viii., ix., x. are respectively on "quartic curves" (pp. 101–132), "bicircular quartics" (pp. 133–161), "special quartics" (pp. 162–204). Non-singular, or, as the author prefers to call them, anautotomic quartics, receive attention for three pages only (115, 117, 122). The special quartics discussed are the cassinian, the lemniscates of Bernoulli and Gerono, cartesians, limaçons, the cardioid and the conchoid of Nicomedes. Chapter xi. treats of "miscellaneous curves," roulettes, the evolute of an ellipse, the involute of a circle, the catenary, tractory, elastica and spirals. Chapter xii. is on projection. Some useful references are given in footnotes.

The author has not found space for any general discussion of the forms of cubic and quartic curves, or of the expressions for the coordinates of a variable point on a curve in terms of a parameter, even when the curve is unicursal. The theory of residuation is not mentioned. The following are some of the matters of detail in which the book might be improved.

It is a good thing to "give special prominence to geometrical methods," but we do not think it is sound to estimate, say, the number of tangents that can be drawn from a cusp, real or imaginary, by inspection of the figure (p. 18), especially when no discussion of the form of a curve near a real cusp has been given; the question is in its essence an algebraical one and cannot really be decided except on algebraical grounds.

A process is given (§ 2) for finding the eliminant of two binary quantics of degree n. The result would be of the degree 2^n in the coefficients.

The condition given on p. 4 for the equality of r roots of an equation would lead us to conclude that the equation $3x^4 - 4x^3 + 1 = 0$ has three equal roots.

In the proof of Plücker's equations (chap. iv.) it is only shown that m cannot exceed $n(n-1) - 2\delta - 3\kappa$, and that ι cannot exceed $3n(n-2) - 6\delta - 8\kappa$. It is not proved that the curve and the Hessian meet only at multiple points and points of inflexion.

On p. 62 it is proved that the node of a nodal cubic is a pole of the line of inflexions. The author must have forgotten for the moment that the node is a pole of any line whatever in the plane.

Cayley's theory of conjugate poles on the Hessian of a cubic is treated by means of trilinear coordinates; the figure on p. 70 does not altogether correspond with the text, for it is proved that K lies on the line PQ and that C(AMBK) is a harmonic pencil. Also it is surely wrong to say that when "A is given, there are in general three conjugate poles corresponding to A" (p. 71).

The proof (p. 115) that a quartic cannot have more than eight real points of inflexion is very flimsy; it consists of an appeal to an extreme limiting case.

The assumption that a ternary quartic can be put in the form $lU^2 + mV^2 + nW^2$ is justified by counting the constants (p. 117), although later (p. 240) the reader is very rightly warned "that counting the constants is not always a safe process."

On p. 122 we have the theorem:—

"A conic can be drawn through the eight points of contact of any four double tangents to a quartic." It is well known that this is not true, and it is, in fact, inconsistent with the theorem at the foot of the same page.

There are some other points on which we do not agree with the author, but notwithstanding its drawbacks, the book contains much that is interesting and important.

OUR BOOK SHELF.

Pharmacopedia, a Commentary on the British Pharmacopoeia, 1898. By Edmund White, B.Sc. (London), F.I.C., Pharmaceutist to St. Thomas's Hospital, London, and John Humphrey. Pp. xv+696; 46 plates. (London: Henry Kimpton, 1901.)

THE subject of materia medica is already somewhat unnecessarily complicated in its terminology; the student has to learn the meaning of a formidable array of words before he can even define the subject-matter of his studies. *Inter alia* we may mention pharmacology, pharmacognosy, pharmaco-dynamics, pharmacy, pharmaceutical chemistry, &c. Into this sea of shibboleths the authors of this work have flung yet another which doubtless they hope will float, viz. Pharmacopedia; this in its turn will probably produce Pharmacopedies; by it the authors understand "information about drugs." We venture to think that one of the few mistakes of the book is its title.

The book consists of a full description, either botanical or chemical or both, of all the officinal drugs in the pharmacopœia of 1898, and their preparations. The drugs are treated in alphabetical order, and in this order also the different kinds of preparations are considered generically. The authors have rightly devoted space liberally to the chemical problems involved in the preparation of medicines. They have also discussed at length most of what is known concerning the chemistry of the alkaloids, enlarging this in many cases to a detailed account of the organic chemistry, not only of the substances immediately under consideration, but also those through which their molecular constitution has been ascertained. We may, however, remark parenthetically that we think coniine and digitalis have been treated in this respect a little scantily.

The new synthetic remedies, *e.g.* antipyrin, phenacetine, saccharine, are, so far as their chemistry is concerned, treated very fully, and this will add very greatly to the value of the book. The general remarks upon the oils, methods of standardisation, &c., are also very good and will prove useful to the student.

The book concludes with notes on the Indian and Colonial addendum of 1900 and with numerous well-executed plates of medicinal plants.

The book is well got up, and, as a book of reference like this ought to be, is actually bound, not, as is so often the case, merely enclosed in cloth covers. The authors are distinctly to be congratulated upon the result of their labours and may certainly consider that they have produced the most complete commentary upon the pharmacopœia, from the point of view of the student of pharmaceutical chemistry, in the language. The reviewer would suggest to them that in the next edition they should include once under each drug a brief account of its action and uses, and also its dose. This could be done without appreciably increasing the bulk of the volume and would add immensely to its practical value. F. W. T.

Practical Exercises on Sound, Light and Heat. By J. S. Dexter, B.Sc. Pp. xv + 284. (Longmans, Green and Co., 1901.) Price 2*s.* 6*d.*

THIS book contains elementary exercises, and is of a standard suitable for the work of science and continuation schools and for junior university students. It contains 218 sections dealing with the three subjects, so that the field is covered very completely.

The experiments on heat commence with some to illustrate the sensation of touch used as a thermoscope, and an account, which the student is recommended to take as a guide, is given of the observations. The account begins: "From this lesson I learn that my sensation of touch must not be relied upon to tell me the true heat state of the body I am examining. The thermometer given me to use made no indications of change when placed on different articles, such as wood, iron, or duster, and yet I have different sensations on touching them. . . ." The present writer feels that it would be better for the students, however young, to learn at once the normal English method of recording results and conclusions. He would put the observations first and the conclusion afterwards and avoid the personal pronoun, so that the example for the student would read thus: "A thermometer made no indication of change when placed on the following articles wood, iron or duster, but the sensation to touch was different in each case. . . . From these observations it appears that the sensation of touch cannot be trusted to indicate the heat state of a body."

The methods described by the author for many of the experiments are very simple and satisfactory. We may mention the method of measuring the coefficient of expansion of a rod, and the numerical results show that a good degree of accuracy can be attained. We should, however, have liked to have seen a chapter on the discussion of the value of the errors in the methods. It is not well that students should learn to measure one quantity to five significant figures, another to three and to multiply the two, obtaining a result with eight as we see on p. 47. S. S.

Die heterogenen Gleichgewichte vom Standpunkt der Phasenlehre. Von H. W. Bakhuis Roozeboom. Erstes Heft: Die Phasenlehre—Systeme aus einer Komponente. Pp. xiii + 221. (Braunschweig: Vieweg und Sohn, 1901.)

THIS book will receive a warm welcome from all interested in the phase-rule. Prof. Bakhuis Roozeboom has made the experimental portion of the subject peculiarly his own, and now lays chemists under an obligation of gratitude for a clear and systematic account of Gibbs's rule and its applications. The work is divided into sections according to the number of components in the systems considered, and then further subdivided according to the number of phases in the systems. This method of classification is very advantageous for detailed treatment, especially when many illustrative instances are given, as is here the case. The present section of the book, after a brief general sketch of the nature of the phase-rule, deals with systems containing only one component, the remarkable amount of interesting material collected and classified under this heading showing very strikingly the value of the rule for systematic purposes. Amongst the subjects treated we find the ordinary equilibria of solids, liquids and gases, isomerism, rate of crystallisation, critical points, triple points, transformation points and curves, liquid crystals, enantiotropy—all fully illustrated by examples and with indications of the experimental methods employed. Graphic methods are freely used in the exposition, and only the most elementary acquaintance with mathematics is required for the perusal of the systematic portion of the work. Two other sections are promised, dealing with the equilibrium of systems containing respectively two and three components. J. W.

Knowledge Diary and Scientific Handbook for 1902. Pp. 112+408. (London: *Knowledge* Office.) Price 3*s.* net.

AMATEUR astronomers and other observers of natural phenomena will find it a convenience to possess this diary and handbook. There are, in addition to the 408 blank pages of the diary, several descriptive articles on aspects of astronomy, botany, microscopy and meteorology; star maps; diagrams of paths of the chief planets in 1902; collections of tables of service to students of science; a monthly astronomical ephemeris; and other information of interest.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

Kites and Wireless Telegraphy.

IN view of the current report in the daily Press that Mr. Marconi has succeeded in receiving at St. John's, Newfoundland, by means of a wire raised with a kite, signals sent from his station at Poldhu, Cornwall, it may be interesting to recall that kites were used here during the summer of 1899 in some similar experiments. In the "Report of S. P. Langley, Secretary of the Smithsonian Institution, for the Year ending June 30, 1900," it is stated on p. 10: "In addition to the above investigations a Hodgkins grant has been approved to enable Mr. Rotch to carry on a series of experiments in space telegraphy, it being thought that the unprecedented heights attained by kites might materially extend the range of communication by this method. In the preliminary experiments, however, kites were not used, sufficient elevation being attainable without them, but when the difference between the stations was increased from one mile to three, kites were employed to raise the transmitting and receiving wires. In the later experiments it was found, not unexpectedly, that the long wires, carried up and supported by kites, collected so much electricity as to interfere with and greatly complicate the messages sent from station to station. These interruptions seem to show that the limit of elevation for the receiving wire was under these conditions less than five hundred feet. The greatest distance covered in the experiments was approximately twelve miles, from a wire supported by a kite about two hundred feet above Blue Hill to the tower of Memorial Hall in Cambridge, which was used as the receiving station. These experiments draw attention to the fact that electrification increases with the altitude to which the wire is carried, and that it is always present, although varying with the meteorological condition of the atmosphere. The experiments were discontinued in the autumn of 1899."

If Mr. Marconi, by his system, has really received signals from across the Atlantic, with the receiving wire lifted by a kite to an altitude exceeding five hundred feet, it would appear from my experiments that he must have employed some hitherto unknown method of shunting out atmospheric electricity.

A. LAWRENCE ROTCH.

Blue Hill Meteorological Observatory,
Mass, U.S.A., December 17, 1901.

Poisonous Molluscs.

I NOTICE that doubt is cast on the opinion held by some authorities that the bite of certain species of Conus is poisonous; and as a case has now occurred here in a European subject whose intelligence places her account of it beyond question, I think it may be useful to represent the corroborative evidence thus obtained.

I should mention, first, that a shell exactly similar to the one in question was forwarded to the Australian Museum, Sydney, and that I am indebted to Mr. Etheridge, the curator, for information on the point and for the identification of the specimen as the shell of *Conus geographicus*.

The patient, Mrs. B., was fishing from a boat after dark in the harbour of Levuka (Fiji), and one of the crew handed her a mollusc he had picked up in shallow water at low tide while getting bait—a *C. geographicus*. Mrs. B., being an old resident in the islands, proceeded to evulse the mollusc with her little finger, the boy having cracked the shell to facilitate this procedure. While doing so she received a puncture, and shortly afterwards felt her hand and fore-arm becoming numb. The effect quickly extended to the shoulder, and the patient had to return to the shore and be conveyed home. In an hour or so she was in great distress, speechless, and paralysed in most of the voluntary muscles; a condition which later became intensified and alarming, although the cardiac and respiratory muscles showed no evidence of flagging. The medical man who attended Mrs. B. likened her condition to that which might be looked for after poisoning by *curare*.

The puncture was so slight as to be scarcely discernible; after two days a steady but slow recovery took place, and a fatal termination was averted.

During this time the patient did not lose consciousness; but there was for a while some confusion of ideas, and, chiefly in consequence of the loss of power in the muscles concerned in articulation, she was unable to speak intelligibly, although she subsequently asserted that she knew quite well what was going on around her. She underwent an attack of conjunctivitis a few days later, which she connects with the occurrence; but it is doubtful whether she is right or not in so believing.

R. GLANVILL CORNEY.

Medical Department, Fiji, September 30, 1901.

The Distance of Nova Persei.

IT appears to me that the phenomenon of the apparent expansion of the nebula surrounding Nova Persei would be simply explained by referring it to the illumination of meteoric matter by the light sent out on the occasion of the outburst of the Nova. On this hypothesis it becomes possible to calculate the distance from the earth by means of the observed angular growth of the illuminated ring which must spread out with the velocity of light. This gives 313 light-years as the distance.

Daramona. W. E. WILSON.

Colours of Butterflies not due to Diffraction.

SOME time ago your correspondent, Mr. Benham, corrected the mistake that mother-of-pearl owes its beauty to diffracted light. The error had lived long, partly, perhaps, because it came from an authority so eminent as Sir David Brewster.

A similar idea seems to be still prevalent, that butterflies and moths derive their colours from diffraction. Two of the best modern natural histories, which I have at hand, favour the supposition.

The patches on the wing are groups of uniformly coloured scales, which contain pigment. Diffraction colours are of a different character; they are many-coloured iridescent lights varying as they glance off at different angles. The distinction is familiar to a worker in optics; it is easy for anyone to appreciate it by seeing recognised forms of diffraction. I have lately examined a collection of British Lepidoptera, and found no specimens which were coloured by wave interference. The Purple Emperor has two uniform colours, grey and purple, so arranged that there is a direction of vision favourable for seeing each colour. Shot silks and Labrador spar are cases somewhat similar. I have before me a foreign Thecla which has a brilliant light-blue pigment; perhaps in this and some others a certain shimmer is added by a slight diffraction interference, but the predominant effect is the blue colouring matter.

It is, however, interesting to note that all scales have fine diffraction rulings. These lines, as in the case of diatoms, consist of rows of small spots. I have had a wing of the Small Tortoiseshell for about twenty years; the scales are complete, but the colours are faint, and the wing is partly transparent. It is possible to arrange this with care in a strong light so that brilliant rainbow lights are seen, but they are not the familiar tortoiseshell pattern. This effect does not seem to be possible with a fresh wing, so that I doubt whether butterflies are often seen to act as diffraction gratings. No doubt some insects show interference colours, but these seem usually to arise from the phenomenon caused by thin plates. Diffraction can be well studied in humming-birds; there are the brilliant, ever-varying lights, and the fine markings on the feathers may be seen with a microscope. No iridescence is more delicate than that on the side of a fresh mackerel. I am not quite sure to which class of wave interference this is due.

W. B. CROFT.

Winchester College, December 30, 1901.

The Quadrantid Meteors.

NOT the least important of our annual star showers are the Quadrantids, so called from the position of their radiant in the constellation of Quadrans Muralis, which is situated between Boötes and Draco. This meteor-system

has not had the same attention lavished on it as has been given to the more historic epochs of the Leonids, Lyrids and Perseids. Yet occasionally, even when only moderately active, the Quadrantid Radiant furnishes displays of about 40 meteors per hour. In the year 1839 Herrick drew attention to the recurring character of a meteor shower on January 2. A stimulus was given in the same direction when in 1839 Quetelet published his valuable contribution to meteoric literature in his "Catalogue des Principales Apparitions d'Etoiles Filantes," in which were cited two instances when meteors were reported to have been unusually numerous on the morning of January 2, viz. in 1835 and 1838. There was also a previous account of the appearance of an extraordinary bolide in the north of Italy in the year 1825, on the morning of January 2 at 5 o'clock, before and after which hour on that night there was noticed a great abundance of meteors.

When Quetelet published a second edition of his work a few years later it contained notices of Quadrantid displays on the same day of the month in the intervening years 1839 and 1840. Their observation in those years, however, may have been due to their having been specially looked for. The next notable display occurred in 1862, and was accidentally witnessed on the morning of January 2, between about 4 and 5 o'clock, by a lady residing in Harford, Connecticut, U.S., who on this occasion seems to have had the honour of being the sole observer of the apparition. Her attention was attracted by a luminous cloud moving from west to east, and also by the appearance of fine meteors at the rate of about three per minute. Two years later there occurred another display in England, on the night, however, instead of the morning of January 2, for which an organised watch had been kept. Profs. Herschel and Gregg (British Association Report, 1864, p. 30) each observed fifty shooting stars from different stations during the hours 10 to 12 p.m. and 10 to 1 respectively, while another observer, Mr. W. H. Wood, reckoned that the Quadrantids were appearing at the rate of one per minute during the hours 12 to 2. Prof Kirkwood, who instituted researches respecting the periodicity of these meteors and also of other meteor-systems, showed in a paper read before the American Philosophical Society in 1873 that the Quadrantid maximum recurred every thirteen years, the principal displays having taken place in 1825, 1838 and 1864. The intervening maximum between the two last dates is supposed, of course, to have passed unnoticed.

The expected shower, however, in 1877 was looked for in vain owing to unfavourable weather, but on the morning of January 2 in the following year, during a brief interval of clear sky beginning at 4 o'clock, Prof. Herschel noted the appearance of seventeen Quadrantids, nearly half of which ranged in brightness from the brilliancy of Sirius to that of second magnitude stars. Weaker apparitions from the Quadrantid radiant also occurred on the nights of January 2 in the years 1872 and 1873, but seem to have been only partially or imperfectly observed. The circumstance that the principal appearances of these meteors evidently took place in 1825, 1838, 1862 and 1864, and (probably) also in 1878 naturally leads to the expectation that another fine display may be observed in 1902. An examination of the dates at which the first three of these showers occurred shows that the Quadrantid meteoric epoch is gradually, as in the case of other well-known star showers, advancing into the year. The advance takes place on the average, however, and is not very noticeable over short periods, being warped by fluctuations in the date of the shower's appearance with respect to the mean date, such fluctuations being produced by the perturbations which occur in the meteoric orbit.

The display in America in the year 1862 and also those on the night of January 2 in 1872 and 1873 illustrate this advance. A calculation made by the writer with such data as the above displays afford shows that the time of the next shower's expected appearance falls on the night of January 4 in 1902, the maximum or centre of the display being due at 3h. 30m. on the morning of the 5th. Earlier in the night, shortly after 12 o'clock, meteors will probably be unusually numerous. The display in 1864 evidently did not attain the brilliancy of the previous displays. Calculation shows that the maximum of this shower occurred about 10 p.m. on the night of January 2, which prevented the shower being fully observed. Probably some early Quadrantids of the expected display will appear on the morning and also early on the night of January 3. The lateness of the maximum on the night of January 4 is more apparent than real, owing to 1900 not being a leap year.

JOHN R. HENRY.

Frost Patterns in Mud.

ON many occasions recently frost patterns in mud have been exceptionally well marked, similar to those formerly described by Prof. Bonney and others (see NATURE, vol. lxiii. p. 347; *Proc.* Roy. Soc, vol. lxiii. p. 217).

On December 15 several of the usual forms were to be seen, the patterns generally being rather coarse, but elaborate, having branched and curving axes.

Thus, (1) on many ordinary flagstones the ice-fronds spread from the centre outwards, over a patch, roughly oval on an oblong stone, roughly circular on a square one, leaving bare a space towards the edge; although sometimes radial or branched forms started from the edge in addition. (2) The centre of the pattern on some flagstones was occupied by a lumpy mass. This consisted of frozen mud, sometimes having a border two to three inches wide formed of scattered separate lumps. (3) One example, however, was rather exceptional. On a concrete path in St. James's Park a space of a few square yards was broken into patches (from a few inches to 2 feet or more in diameter) with outlines roughly hexagonal or partly curved, resembling the ends of basalt columns. In these patches the branching frost-fronds had spread from the centre outwards, while, between the patches, a space about $\frac{1}{3}$ inch broad was clear of ice. This example reminded me of the spheroids with attempts at spherulitic or variolitic structure in various igneous rocks (see *Q.J.G.S.* vol. xlix. p. 155); and here also one asks whether the contraction which caused such jointing was favourable to crystallisation, or did the crystallisation from a centre cause the contraction, or were the two independent though they cooperated to produce the general result?

CATHERINE A. RAISIN.

THE ROYAL COMMISSION ON COAL RESOURCES.

THE announcement that a Royal Commission has been appointed to inquire into the coal resources of the United Kingdom had not been anticipated by public opinion. Yet, in view of the articles on the subject published in NATURE (1897, p. 389, and 1900, p. 124), it should hardly give occasion for surprise. The duration of the British coal supplies is a question that has lost none of its interest since the previous exhaustive inquiry conducted in 1866–1871 by the Royal Commission of which the late Duke of Argyll was chairman. The fifteen Royal Commissioners—all of whom, with one exception, have now passed away—were among the most eminent men of their day, and their calculations were carried out in a thorough and complete manner. In the course of thirty years, however, unexpected changes have taken place in the coal trade. The annual output of coal in the United Kingdom thirty years ago was not more than 100,000,000 tons; it now exceeds 225,000,000 tons, and the process of exhaustion still continues. The beginning of the twentieth century is evidently an opportune time for taking stock of the national resources of the mineral on which so much of the prosperity of the country depends. The new inquiry is to be of a far-reaching character. The terms of reference are as follows: —

To inquire into—(1) The extent and available resources of the coalfields of the United Kingdom; (2) the rate of exhaustion which may be anticipated, having regard to possible economies in use by the substitution of other fuel or the adoption of other kinds of power; (3) the effect of our export of coal on the home supply and the time for which that supply, especially of the more valuable kinds of coal, will probably be available to British consumers, including the Royal Navy, at a cost which would not be detrimental to the general welfare; (4) the possibility of a reduction in that cost by cheaper transport, or by the avoidance of unnecessary waste in working through the adoption of better methods and improved appliances, or through a change in the customary term and provisions of mineral leases; and

(5) whether the mining industry of this country under existing conditions is maintaining its competitive power with the coalfields of other countries.

The chairman of the Commission is the Right Hon. W. L. Jackson, M.P., chairman of the Great Northern Railway Company, and he has fifteen colleagues. Coal-mining interests are represented by Sir W. T. Lewis, the eminent South Wales colliery owner, Sir Lindsay Wood, chairman of the Durham Coal Trade Association, Mr. A. C. Briggs, of Normanton, Yorkshire, Mr. J. S. Dixon, the Scotch coal-master, president of the Institution of Mining Engineers, Mr. A. Sopwith, of Cannock Chase Colliery Company, and Dr. C. Le Neve Foster, F.R.S., professor of mining at the Royal College of Science and Royal School of Mines. The working men's interests are entrusted to Mr. W. Brace, of the South Wales Miners' Federation, and Mr. R. Young, of the Northumberland Miners' Association. Transport interests are in the hands of Sir G. J. Armytage, chairman of the Lancashire and Yorkshire Railway Company, of Mr. Thomas Bell, coal exporter of Newcastle-on-Tyne, and of Mr. J. P. Maclay, shipbroker, of Glasgow. Geology is represented by Mr. J. J. Harris Teall, F.R.S., Director-General of the Geological Survey, by Prof. C. Lapworth, F.R.S., of Birmingham University, and by Dr. E. Hull, F.R.S., formerly Director of the Geological Survey of Ireland, whilst chemistry is represented by Prof. H. B. Dixon. F.R.S., of Owens College, Manchester.

The main interests involved are thus represented with the exception of the consumers. The metallurgical industries, which consume such vast quantities of British coal, do not find their spokesmen on the Commission. This is a matter of regret, inasmuch as metallurgy was so largely represented on the previous Commission; and the investigations of Sir Hussey Vivian, Dr. Percy, Mr. Hartley of Wolverhampton, and Mr. G. T. Clark of Dowlais, on waste in combustion were amongst the most valuable of the results of the Commission.

The task of the Royal Commission to estimate the available resources of the British coalfields is one of great difficulty, and it is to be feared that any estimate must be of slight value, owing to the impossibility of prophesying with accuracy either the rate of increase in production and consumption, or the limits at which mining may be carried on with profit. Prof. Hull, one of the Commissioners, has already published a reassuring estimate, although it is not in accord with the less optimistic and divergent views expressed by Prof. Stanley Jevons, by Mr. Leonard H. Courtney, by Mr. R. Price-Williams and by Mr. T. Forster Brown. The questions of the possible economies in the use of coal and of the adoption of better methods of working should prove the most fruitful field for the Commission's labours. Great Britain now produces one-third of the world's supply of coal; and more and more attention is being devoted to improvements in mining details. Although the use of mechanical coal cutters has by no means become as general as it has in the United States, where 25 per cent. of the output is thus obtained, there has recently been a distinct increase in the use of these labour-saving appliances. Moreover, endeavours are being made to economise in the consumption of coal, notably in the South Staffordshire coalfield, where the producer-gas invented by Dr. Ludwig Mond has recently been introduced as a cheap source of heat and power. That great economies in the home consumption of coal have been effected since 1871 is unquestionable. Indeed, Mr. Price-Williams has shown that, whereas in 1871 the iron and steel trade required 30 per cent. of the coal consumed in the United Kingdom, its requirements had been reduced to 16 per cent. at the time he read his paper before the Statistical Society in 1889. To further coal economies effected in the manufacture of iron and steel Mr. Bennett Brough has drawn attention in an article on the scarcity of coal in the *Nineteenth Century* (April, 1900). There is, however, still room for large economies in coal in the manufacturing industries; and the results of a searching inquiry into the subject cannot fail to be of permanent value and interest.

ON PAPER AND PEROXIDE OF HYDROGEN.

I DESIRE to show by means of the following photographs some special points of interest which occur when certain papers are allowed to produce pictures on a photographic plate in the dark. Some papers are themselves active, that is, if they be simply placed on or near to a photographic plate in the dark they act upon it so that after ordinary development a picture is produced. Other papers which are without this power can be examined by placing them on a photographic plate and putting behind them a plate which is giving off hydrogen peroxide, such as one of plaster of Paris or a pad of blotting-paper which have been soaked in an aqueous solution of this body, or a plate of polished zinc, or a piece of cardboard or glass which has been painted over with copal varnish or other body of that kind. There is also with regard to paper the action of writing and printing ink upon it.

The fibres which are used in paper making are[1] cotton, flax, hemp, wood celluloses, esparto, straw celluloses,

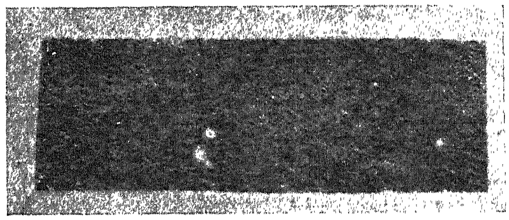

FIG. 1.

mechanical wood pulp. Of these bodies cotton and hemp are entirely without action on a photographic plate; all the other materials are more or less active, especially so is mechanical wood pulp and flax. If, however, any of these bodies, even the most active, be bleached, they lose this activity; the bleaching must, however, be very complete to destroy altogether their activity, and many papers although bleached are still active. On the other hand, the activity of a paper may arise, not from the paper itself, but from the size which has been added; this occurs when rosin is used.

The ordinary first-class papers are entirely without action on a photographic plate, but the common kinds are generally active. For instance, we may take some of the daily newspapers as illustrating this. The following results apply to copies issued on November 25, 1901: the *Standard*, *Daily Express* and *Daily Mail* all gave a dark picture, the *Pall Mall* a good, but not so dark a picture as the former papers; the *Westminster* and the *Sportsman* gave a faint picture, and the *Times*, *Globe* and NATURE only very faint pictures, and, lastly, the *Daily Telegraph*, *Daily News*, *Daily Graphic* and *Morning Leader* gave no picture at all. *Punch* paper is also not active.

With books and periodicals the least expensive are usually the most active; as far as I am aware the paper of high-class books is without action on a photographic plate. Fig. 1 is a picture produced by an active paper.

[1] Report on the Deterioration of Paper, Society of Arts.

This and all the following pictures, when no statement to the contrary is made, have been obtained by an action of the paper on the photographic plate for eighteen hours at a temperature of 55° C. Fig. 2 shows that absolute contact between the active paper and the photographic plate is not necessary, for in this case a thick copper

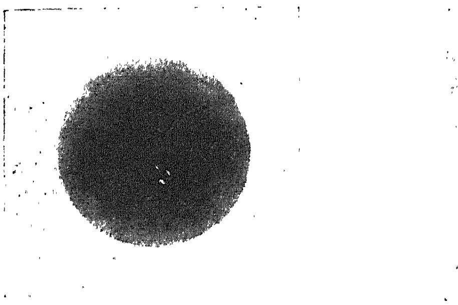

FIG. 2.

screen with a hole in the centre was interposed between the paper and the plate. This action of certain papers is shown in an interesting way with many cardboards. The following experiment, Fig. 3, was made with a photographic mount. A small piece was cut off and on it a long cut was made with a sharp knife passing through the external paper and into the substance of the cardboard. The dark circular patch was where a cork borer had been pressed about half way through the cardboard and the upper part removed. The black ring is a cut made by the same cork borer, but nothing removed. The two dots are two pin holes. Thus it seems as if an active vapour arising from the interior of the cardboard collected in these cavities and acted on the plate. A piece of cork acts in the same way; all the holes give

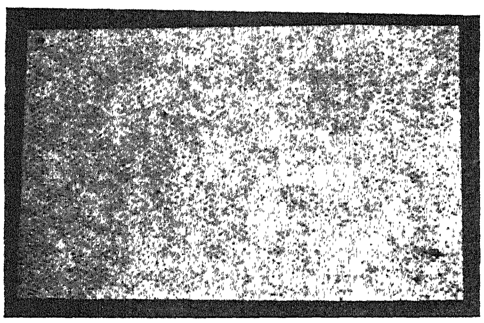

FIG. 4.

black pictures. In this figure the strong action of the recently cut edge is very striking.

Turning now to the case in which the action does not arise from the paper itself, but from hydrogen peroxide purposely placed behind the paper, we can obtain, again, some interesting results. The best way of applying the hydrogen peroxide is by means of a slab of plaster of Paris. This should be cast on a plate of glass and be about a quarter of an inch or slightly more in thickness. After it has been allowed to dry it may be painted over or dipped into a strong or weak solution of the peroxide of hydrogen. The slab is again allowed to dry. It will increase in activity for the first two days and after then gradually decrease, and if a 15 per cent. solution has been used it will be about ten days before it has lost its power of acting on a photographic plate. Other sources of hydrogen peroxide that are convenient to use are a bright zinc plate, or a piece of Bristol board, or a glass plate, that have been painted over with picture copal. Fig. 4 is a picture of the paper of the *Times* produced by placing it on a photographic plate and a charged slab behind it for four minutes. Fig. 5 is the picture of a writing paper 150 years old. The exposure to the hydro-

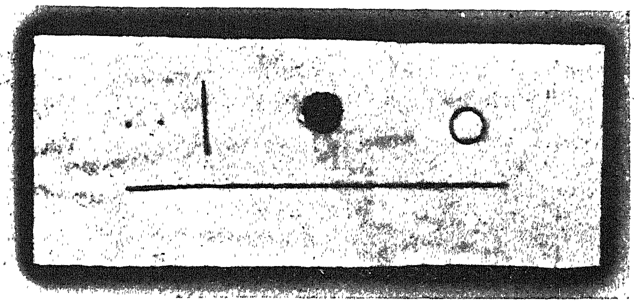

FIG. 3.

gen peroxide in this case was eight minutes, as the paper was thicker and less easily permeated by the peroxide. In the same way it is easy to obtain a good picture of the water-mark on a paper.

This application of the hydrogen peroxide to the back

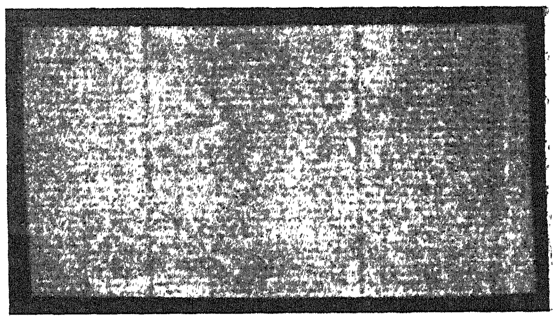

FIG. 5.

of a paper shows an interesting change which paper undergoes on being wetted. Take a paper which is easily permeated by hydrogen peroxide, wet it thoroughly in water, then hang it up at the ordinary temperature until

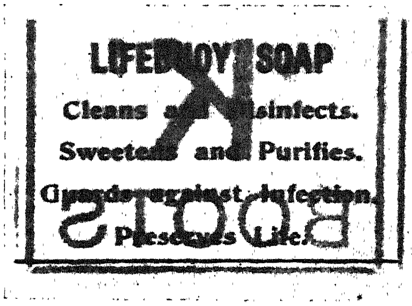

FIG. 6.

perfectly dry, and it will be found to be quite opaque to the hydrogen peroxide given off from a zinc plate or from copal or turpentine. This opacity of the paper, however, gradually passes off, and after two to three days

at an ordinary temperature, or six hours at 100°, it has returned to its transparent state. With Ford blotting-paper the time of recovery is longer. On the other hand, if a paper be made only slightly moist, this facilitates the passage of the peroxide through it. If different substances be dissolved in the water used for wetting the paper it modifies the result obtained. With some substances the paper is not permanently affected, but with others—such, for instance, as alum—the paper remains opaque.

If paper be either written or printed on, the different effects which are produced have been already described.

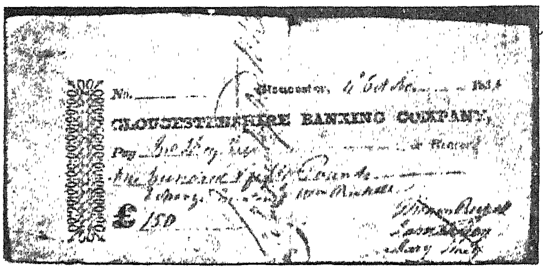

FIG. 7.

The ordinary writing ink, allowed to dry on paper, renders it perfectly opaque to the action of the peroxide and retains this power for a very long time. The direction of a letter written in 1801 shows the writing with remarkable sharpness. The picture was produced by placing a zinc plate behind the letter. Then with regard to printing ink, it is a body which in itself is active, so that it has only to be brought in contact or in proximity to a photographic plate to give a picture. Naturally the activity of the ink varies much in different cases, and is in most cases capable of giving, not only a picture where the ink is facing the plate, but the printing

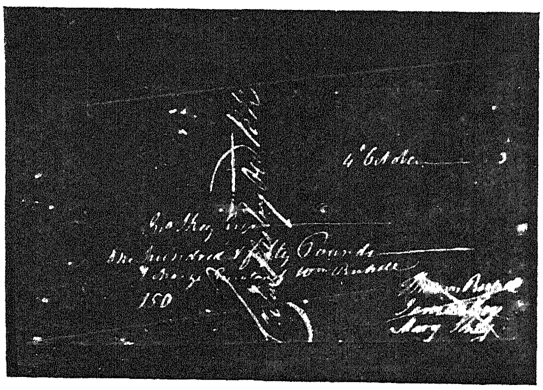

FIG. 8.

on the other side of the paper will also be depicted on the photographic plate. Fig. 6 shows this very well, the printing on both sides of the paper being very evident.

This difference of the action of writing and printing ink is well shown in the two pictures of an old cheque, Figs. 7 and 8. No. 7 is simply an ordinary photograph of the cheque, but No. 8 is a picture of the same cheque produced by placing it on a photographic plate with a zinc plate behind it; the printing-ink has become inactive, but the writing ink is still able to prevent the hydrogen peroxide from passing through.

W. J. RUSSELL.

WHAT ARE SEISMOMETERS INDICATING?

ONE thing which a modern seismometer does, and does in a satisfactory manner, is to indicate the time of arrival of the various phases of motion which constitute an earthquake. With two similar instruments at the same station, the time of commencement of a given earthquake is practically identical; but if the installations of the instruments are different—for example, if the instruments rest upon piers of different heights and construction—it will only be the pronounced phases of the subsequent movements that can be identified and which, therefore, can be compared. If our instruments, instead of being in the same room, are 100 to 800 feet apart, the only points in the two seismograms which can be identified will be the commencements and the pronounced shocks, which latter are of rare occurrence (see British Association Reports, 1885). As a rule not only will the general appearance of the seismograms be different, but measurements will show the existence of differences in period and amplitude. This being the case for seismograms obtained at stations near to each other, what coincidences can we possibly hope for in seismograms obtained at stations located at a few, several hundreds or several thousands of miles from each other?

Next, if we turn to a consideration of the character of the earth movements which produce seismograms relating to earthquakes the origins of which are at a great distance, we meet with observations the explanation of which is not simple. The first rapidly recurring tremors that a seismograph records are regarded as elastic waves of compression and rarefaction. One reason for this belief is that the observed velocities with which these precursors traverse either the surface materials or the body of the earth are such as would be expected for this particular form of wave in the media considered.

Following these forerunners by an interval of time which increases with the distance of the observing station from the earthquake origin are a series of more pronounced movements, usually referred to as shocks or large waves, about the character of which there have been differences of opinion. For earthquakes originating within a few hundred miles of an observing station we find that the records of such waves obtained from bracket seismographs are described as horizontal movements, whilst those from spring-lever seismographs are referred to as vertical components of motion. So long as the latter records are not shown upon a seismogram the former have always been regarded as described, their apparent magnitude being dependent on the multiplication of the writing indices. When, however, in a register we see entries for "vertical motion," neither the measurements for this nor for the corresponding entry for horizontal displacement can be relied upon. The reason for this statement, first made more than ten years ago, is that with severe earthquakes for 100 or more miles round the epicentre we have a vast amount of evidence showing that the ground is thrown into a series of surface-waves. These angular displacements cause horizontal pendulums to swing from side to side, whilst the levers of lever seismographs move up and down, the result being that both types of instruments, instead of measuring components of motion relatively to steady points, act as indifferent clinographs. In consequence of these considerations, at the end of 1891 I designed a clinometer for earthquakes. Briefly, this consisted of a balance-beam loaded at its two extremities, which when its frame was tilted in a direction at right angles to its length was assumed to retain its horizontality. A pointer like that of an ordinary balance attached to this beam acted as a steady fulcrum for the short arm of a light lever, the outer end of which rested on a smoked glass surface. An example of the seismograms giving the period and slope of earthquake-waves obtained by this apparatus will be found in the British Association Reports, 1893.

Inasmuch as these surface-waves could be recognised at a distance of a few hundred miles from their origin, it was naturally assumed that the movements resulting from unusually large disturbances which not unfrequently travel to their antipodes should exhibit the same undulating characteristics. Some support to this view was found in the large movements of delicately adjusted horizontal pendulums, the movements recorded in the traces from magnetographs and barographs, whilst the movements occasionally noted of the bubbles in astronomical levels or the shifting of a star in a telescopic field, together with other phenomena, tended to strengthen the view that the large waves in seismograms represented actual earth tilting. Although I do not yet see how certain of these phenomena can be explained on the assumption of purely horizontal movements, especially when the period of these may exceed twenty seconds, in a British Association Report (September 1900) I published observations indicating that the surface-wave theory met with so many objections that it could not be generally applied. One objection rested upon observations indicating that the velocity of propagation of these waves did not appear to be constant.

Although for certain practical purposes it may be assumed that the arcual velocity of these movements is 3 km. per second, there is evidence to show that they have an initial velocity of about 2 km., whilst their quadrantal velocity approaches 4 km. per second. Dr. C. G. Knott, who has done so much for practical and theoretical seismology, at once pointed out that any change in speed was a serious stumbling-block to the surface-wave theory, which he had always regarded with disfavour. As an alternative, in the *Scottish Geographical Magazine* (January 1899), and in other publications, he showed that the observations relating to speed could be satisfied by the assumption of a distortional mass wave, and it is to the outcrop of such waves to which Dr. Knott looked for the explanation of the large movements of the seismograph.

This hypothesis, however, does not tell us whether the movements actuating a seismograph are vertical, horizontal or angular. Many years ago Dr. A. Cancani pointed out that if these waves represent tilting, from the angular values of the same and the length of the waves which can be deduced from their period and velocity, then on the assumption of simple harmonic motion the height of such waves could be calculated.

Such heights have been frequently estimated, but in the British Association Report (September 1900), p. 83, attention is called to the fact that as these represent accelerations not unfrequently 1/50 of gravity, the existence of these vertical displacements is doubtful, and an experiment to confirm or modify our views was in progress.

The "experiment" referred to consisted in observing the movements of a pointer attached to the earth relatively to the pointer of a clinograph similar to, but much larger than, the one described above. Any relative movement of these pointers would be shown by the displacement of a spot of light reflected from a mirror hung by a bifilar attachment to the two pointers. Subsequently the record was made mechanical. With the first installation 1 mm. deflection =0″·7, and in the second 6″·0. Although several large earthquakes occurred, no record was obtained.

In another experiment slight records were obtained from the photographic registration of a spot of light reflected from a mirror which was caused to rotate by the rising or falling of a weight attached to an ordinary spiral spring. The length of the spring under the influence of its own weight is 9·5 inches. With a load of 1 lb. 8 ozs. its length was 3 feet 5 inches and its natural period 2 seconds.

The earthquake of October 9, 1900, caused ripples on the photogram each about ·5 mm. in range, which would correspond to a change that might have been produced by increasing and decreasing the load by 1/700 part of itself. The period of motion was approximately 6·5 minutes, which corresponded with the period of maxima in the large waves as in an ordinary seismogram.

The Venezuela earthquake of October 29 gave deflections of half the above and with periods of about 7 minutes. Other earthquakes caused somewhat similar movements, but usually nothing more than slight blurs upon the photographic traces were to be seen.

The records from the clinometer indicate that earth tilting has not been measurable by the instrument employed, whilst the records from the spiral spring show that there is a possibility that vertical motion may exist, but if it does it is exceedingly minute.

The general inference is that the large waves due to earthquakes originating at a distance, whether they are surface waves or mass waves, actuate horizontal pendulums by horizontal displacements of the ground, rather than by the tilting of the same.

The distinguished seismologist, Dr. F. Ōmori (see "Publications of the Earthquake Investigation Committee," Tokyo, No. 5, January, 1901), and Dr. Wilhelm Schlütter (see his "Inaugural Dissertation," Göttingen, 1901) have recently expressed similar views. Dr. Omori's objection to the surface-wave theory is based partly upon the impossibility of accepting the vertical accelerations calculated on the assumption that seismographs have acted as clinometers, a view already expressed by Dr. C. G. Knott, Dr. C. Davidson, myself and other physicists, and partly upon the observations he has made showing that the amplitude of seismograms depends upon the multiplication of the writing pointers rather than the sensibilities of seismographs to tilting.

Dr. Schlütter's conclusions are arrived at from the fact that some twenty earthquakes failed to yield any record on the photograms obtained from a "klinograph," which in general arrangement is not unlike those already referred to, but very much more sensitive. The care which Dr. Schlütter took to ensure accuracy can only be realised by reference to his memoir, which, as an essay relating to this class of investigation, stands *facile princeps*.

The general conclusions arrived at are that for severe earthquakes with a near origin, surface earth-waves may be marked. To record these clinographs are required, and the entries in registers referring to the same should be correspondingly modified. In designing instruments to record earthquakes with a distant origin, the principle introduced by Prof. J. A. Ewing into seismometry relating to steady points must be carefully observed, and in our registers we must regard our entries as referring to displacements which are horizontal rather than angular.

J. MILNE.

ELEMENTARY MEDICAL EDUCATION.

WE have received a memorial to the General Medical Council concerning the relegation of the teaching of elementary chemistry, physics and biology to the school, as distinguished from the medical school. The memorial is signed by a number of men of science, teachers of botany, zoology, chemistry or physics. In the opinion of these gentlemen the above subjects should be permanently retained as part of the medical curriculum proper, and their relegation to the schools is, according to them, likely to have a prejudicial influence upon medical education. The most powerful argument, so far as we can see, brought forward in support of this hypothesis is that the schoolboy, as distinguished from the medical student, is intellectually less capable of grasping those scientific generalisations without which the teaching of the elementary scientific subjects above named would not be productive of the desired result, viz. the

development of a truly scientific mind. This as a general statement may perhaps be admitted, though it must be at once pointed out that the difference between the intellectuality of a schoolboy aged sixteen and of a medical student aged seventeen *qua* age is not great, if it exists at all, and postponement of the teaching in these subjects beyond seventeen or eighteen would certainly be impossible.

All are agreed that the attainment of scientific methods of observation and reasoning is a quality of the first importance to the future medical man, especially as the ultimate result of his education, viz. the practice of medicine or surgery, is essentially an inexact science, one in which the data for the formulation of conclusions are extraordinarily inconstant and ephemeral, often demanding for their detection the most trained observation, and for their elucidation the most careful reasoning.

The medical curiculum is, however, filled to the bursting, and unless we want the student to emerge from it partially insane, some depletion must take place. It should also be remembered in this connection that intellectual attainments are not the sole requirements of the medical man. Manipulative skill, and, further, physical training, rendering him capable of enduring physical strain, are also practically essential. This and the fact that the actual subject-matter of medicine and surgery has increased enormously during the last few years, not merely in the direction of biology, chemistry and physics, but also in that of the actual accumulation of clinical fact, render the intellectual burden to be laid, according to the present arrangements, upon the medical student more than he can bear.

Further, the student of medicine stands in a peculiar position with regard to chemistry, biology and physics, for while it is not to be denied that a clear understanding of them is necessary to his education, yet nevertheless it is not only from them that he receives training in the methods of pure science. After having mastered the essential principles of these he still spends two years or more in the study of science, preparatory to entering upon the subject-matter proper of his profession. The first, second, and often third year are devoted to physiology, anatomy and pharmacology; all subjects which tend, not only to store the mind with fact, but also to educate it in scientific method. If the training of the medical student in scientific method depended solely upon the teaching in chemistry, physics and biology, referred to in the memorial we have received, we confess that we should view with concern the relegation of these subjects to the schools; clearly, however, this is not the case, and since something must be done to relieve the overwhelming mass of knowledge to be acquired by the average student in five short years, we feel that the General Medical Council are acting wisely in demanding more of the schools. It is, however, to be hoped that it will see that the school teaching in these subjects is efficient and that the student comes up to the medical school thoroughly grounded in them.

F. W. T.

SUMMARY OF PROGRESS OF THE GEOLOGICAL SURVEY.

THE publication of the Summary of Progress of our British Geological Survey for the year 1900 has evidently been delayed, for we have long ago received and noticed the annual reports of the Canadian and Indian Geological Surveys, and we have likewise referred to the retirement of Sir Archibald Geikie, who in this publication issues his last official report on the work which for so many years he directed. It is a report which, as usual, provides material of sufficient diversity to interest students of all branches of geology. Those who cultivate a knowledge of the oldest rocks will find ample material for consideration in the accounts of the Moine schists and Muscovite-biotite gneiss of Ross-shire, and in the fuller descriptions of the Dalradian or younger schists of the central Scottish Highlands. Thrust-planes and the phenomena of thermo-metamorphism and contact-metamorphism are dealt with, as well as the relations of the schists to the older and newer granites and other igneous rocks. Outside the great granite masses of Lochnagar and the Cairngorm Mountains there is an exceptional extension of cordierite-hornfels, due to the alteration of aluminous black schist; while impure limestones are characterised by the development of silicates, of garnet, idocrase, malacolite and wollastonite. Special attention is drawn to the distinction which it is sought to make between the band of schists known to the surveyors as the "Green beds," originally sedimentary rocks, and the Epidiorites, which occur as sills of much-foliated igneous rock. The "Boulder bed" also forms an important horizon in the mass of Dalradian schists. In some places it affords evidence of having been in part a true conglomerate before any movement such as shearing or crushing took place; elsewhere it appears as a crush conglomerate, or it presents an "augen-structure" on a gigantic scale. In Ireland attention was mainly given to the Silurian rocks of Waterford and Wexford and their associated intrusive and volcanic rocks, which are described in some detail. In the south-west of England work was carried on among the Lower Devonian rocks of Looe in Cornwall and on the various subdivisions of the "Killas" near Falmouth, the "greenstones," and the granite of Penryn.

In the great South Wales coal-field work has been vigorously prosecuted in the district around Swansea. There the Old Red Sandstone and the Lower Carboniferous rocks are of especial interest in connection with their Devonshire equivalents, and it is of the highest interest to learn that radiolarian chert has been recognised in the Gower series described long ago by De la Beche and compared by him with the Coddon Hill beds of North Devon.

The Gower series occurs on top of the main mass of Carboniferous Limestone and belongs to the group of "Upper Limestone shales." These are represented on the north crop of the South Wales coal-basin by "Rottenstone shales," in which also bands of radiolarian chert have been discovered. The upper part of the Gower series consists of a mass of dark shales in which *Goniatites* (*Glyphioceras*) *bilinguis* and *Posidonomya* have been found. At a higher horizon come the hard sandstones and conglomerates of the Millstone Grit. The discovery of these radiolarian cherts is thus an important link in the correlation of the strata in Devonshire and South Wales, for it had been held that the Coddon Hill chert beds might represent the mass of the Carboniferous Limestone. As the work of the Survey proceeds westward further interesting results may be anticipated, especially with regard to comparisons between some of the underlying Lower Carboniferous strata and the Upper Devonian. The Old Red Sandstone has been studied as far north as Caithness, where some of the flags and shales are so bituminous as to become impure oil-shales, while albertite or mineral pitch is found distilled out into the faults and cracks of the strata over large areas. In Argyllshire the relation has been worked out between some of the younger granites of Ben Cruachan, Blackmount and the Moor of Rannoch, and the vents of the Lorne volcanic region. As these vents belong to the time of the Lower Old Red Sandstone, the granites which invade them probably belong to the remarkable series of granite extrusions which in the British Islands intervened between the close of the Upper Silurian and the beginning of the Upper Old Red Sandstone periods.

Details are given of the various coal-seams and of

faults and disturbances observed in the coal-field near Swansea; and important suggestions are made regarding the subdivisions recognised in the Upper Coal-measures of North Staffordshire and their extent westwards across the Cheshire plain, and south-westwards into the Birmingham area.

The discovery of Rhætic, Liassic and Cretaceous fossils in rocks, preserved within an old volcanic vent in the Isle of Arran, is of especial interest as indicating the former extent of these Secondary strata. The Cretaceous rocks of the south of England have received attention, more especially as regards the Lower Greensand of parts of Sussex and the Isle of Wight, the subdivisions in which are compared.

Students of Tertiary strata will find interesting references to the successive overlaps of the London Clay and Bagshot beds on the western side of the Hampshire Basin. The volcanic series of Arran and of Skye come into notice also in the portions of the Summary which deal with Tertiary times.

In various parts of the country observations have been made on Pleistocene deposits, the most important being the full account of the glacial phenomena in the Macclesfield district.

The petrographical work includes a particular account of the marbles of Assynt, which have resulted from contact metamorphism produced by igneous rocks on surrounding dolomites. The palæontological work includes important catalogues of type-specimens of Pleistocene, Pliocene and Devonian fossils preserved in the Museum of Practical Geology; and there are special notes on Carboniferous plants from Berwickshire and on the fossil fishes from the Silurian rocks of the Lesmahagow district. In this brief abstract of some of the results of a year's work on the Geological Survey we have refrained from mentioning individuals, but the work of each has been carefully indicated in the memoir. It is satisfactory, moreover, to note the assistance that has been rendered by Mr. R. Kidston, Dr. R. H. Traquair and Dr. G. J. Hinde in the identification of particular groups of organic remains.

SIR J. HENRY GILBERT, LL.D., F.R.S.

THE names of Lawes and Gilbert have been "household words" in the mouths of English students of agriculture during the past half century. Sir John Lawes departed from amongst us last year, at the age of eighty-five. His colleague, Sir J. H. Gilbert, has also now finished his labours; he died at Harpenden on December 23, at the age of eighty-four.

Joseph Henry Gilbert was the second son of the Rev. Joseph Gilbert, a nonconformist minister at Hull. He was born at Hull in 1817. His mother, Ann Gilbert, was a daughter of the Rev. Isaac Taylor, of Ongar, and thus belonged to a well-known literary family; she was herself the authoress of numerous poems for children. While at school young Gilbert met with a serious accident, and practically lost the sight of one eye. His great pluck enabled him to accomplish his life's work with little apparent hindrance, but the disadvantage of weak sight was very real, and much of his subsequent literary work had to be dictated. He went from school to Glasgow University and studied chemistry under Dr. Thomas Thomson. From thence he went to University College, London, and commenced working in the laboratory of Dr. Antony Todd Thomson. Here apparently he first made the acquaintance of Mr. John Lawes, who was a frequent visitor to the laboratory. He next proceeded to Giessen, where Liebig was then professor of chemistry, and took the degree of Ph.D. in 1840. Dr. Gilbert then acted for a short time as assistant to Dr. Antony Todd Thomson, and afterwards left to take up calico printing and dyeing in the neighbourhood of Manchester.

It was in 1843 that Dr. Gilbert's services were engaged by Mr. Lawes for the agricultural investigations then commencing at Rothamsted. We have already noted in these pages (NATURE, September 13, 1900, p. 467) the foundation of the Rothamsted agricultural investigations by Mr. J. B. Lawes, their rapid development at his sole expense, and their subsequent liberal endowment by him; we have now to mention the important part taken in the work by his collaborator, Dr. Gilbert.

The two investigators were, to a considerable extent, well matched, each supplying some deficiency in the other. Sir John Lawes brought to the work a very original mind, an enterprising spirit, and a thorough knowledge of the facts of practical agriculture; and this practical knowledge served to inform his judgment and enabled him to test the truth of many of the scientific theories which came before him. Sir J. H. Gilbert, on whom the details of the work devolved, brought to his task a more exact knowledge of science and of methods of investigation, an acquaintance with foreign chemists and foreign literature, and, above all, methodical habits of work, which proved of immense value in planning and carrying on through fifty-eight years the field experiments which became such a striking feature in the Rothamsted investigations. He was an indefatigable worker, and loved to accumulate an immense mass of results, frequently of a similar kind; and a reader of Rothamsted papers is sometimes so overwhelmed by numerical statements that, to use a familiar simile, "he finds it difficult to see the wood for the trees."

The Rothamsted investigators soon found themselves engaged in controversy with German men of science, and Sir J. H. Gilbert at once proved himself to be a warm and untiring antagonist. The first subject of dispute was the so-called "mineral theory" of Baron Liebig. Liebig held that the atmosphere supplied in sufficient quantity both the carbon and nitrogen required by crops, and that the proper function of manure was to supply the ash constituents of the crop it was intended to grow. On the other hand, the Rothamsted field experiments with wheat and barley proved unmistakably that ammonium salts and other nitrogenous manures had a far greater effect in increasing the produce than any application of phosphates, potassium salts, or other ash constituents. So long as the question was confined to the cereal crops, Rothamsted was triumphant; but when leguminous crops became the subject of experiment the answer was doubtful, and in many cases the manures supplying ash constituents proved the most effective. It has taken many years, and tasked many investigators, to elucidate this part of the subject. We now know that the roots of leguminous plants become the habitation of certain bacteria, and that by means of these the plants are fed in a special manner with nitrogen from the atmosphere.

The subject of the assimilation of nitrogen by plants led to one of the most highly prized of the Rothamsted investigations, in which plants were grown from seed in soils destitute of nitrogen, but supplied with ash constituents, and in an atmosphere free from ammonia, the object being to ascertain in a rigorous manner if an assimilation of the free nitrogen of the air took place. The work lasted three years, and was made the subject of a communication to the Royal Society by Lawes, Gilbert and Pugh. The chief honour of the work belongs, in this case, to the last-named author. Pugh was an American studying in Germany, and when the controversy on nitrogen assimilation between Boussingault and Ville was at its height he offered to come to Rothamsted and help to solve the question. His offer was accepted. The whole of the experimental work was conducted by Pugh with an ingenuity and accuracy which were justly admired.

In later years another controversy arose as to the part taken by carbohydrates in the formation of animal fat. Lawes and Gilbert had satisfied themselves by their experiments on pigs that fat was undoubtedly produced from carbohydrates. The German physiologists doubted this, and at one time Rothamsted and its followers stood almost alone in their opinion. Now the tide has turned; the experimental evidence for the formation of fat from carbohydrates has become overwhelming, and it is even believed by some that no fat is formed from the albuminoids of the food, but that all the fat stored up by the animal is derived either from carbohydrates or from the fat originally present in the food. The question is one of very great practical importance, the German school formerly insisting that nitrogenous foods must be selected for economic fattening, while the English teaching gave the farmer a much wider choice.

The scope, development and results of the Rothamsted experiments, and the numerous honours jointly conferred on Lawes and Gilbert, have been so recently noticed when speaking of the work accomplished by Sir John Lawes that a repetition of them here seems hardly necessary. Sir J. H. Gilbert was at his death the oldest surviving Fellow of the Chemical Society, having been elected in 1841. He became president of the Society in 1882–3. He was elected a Fellow of the Royal Society in 1860, he served on the Council, and was a regular attendant at the meetings of the Society. With Sir John Lawes he received a Royal medal in 1867. He became a Fellow of the Linnean Society in 1875. He was president of the Chemical Section of the British Association in 1880. He was elected professor of rural economy at Oxford in 1884 and held the office till 1890; the subjects chosen for his lectures were the results of the Rothamsted investigations. He received honorary degrees from several Universities, and was a member of various foreign academies and societies. On the occasion of the jubilee of the Rothamsted experiments in 1893 he was presented with a piece of plate, and afterwards received the honour of knighthood.

Sir J. H. Gilbert carefully maintained through life a connection with foreign workers. His holidays were frequently occupied by visits to scientific meetings and institutions in Germany and France. He made three visits to the United States and Canada, and delivered several lectures there. He enjoyed a very vigorous constitution, and continued actively at work up to the last year of his life. Unfortunately, his disposition forbade his cooperation with any younger colleague, and the institution at Rothamsted is now left without any apparent successor to its historic labours.

The funeral of Sir J. H. Gilbert took place at Harpenden on December 27; deputations from various scientific bodies attended. The Lawes Agricultural Trust was represented by Sir Chas. B. Lawes, Sir John Evans, F.R.S., Mr. W. Carruthers, F.R.S., Prof. H. E. Armstrong, F.R.S., Dr. J. A. Voelcker and Mr. H. Rix; the Board of Agriculture by Mr. T. H. Elliot; the Royal Society by Mr. A. B. Kempe, F.R.S.; the Chemical Society by Prof. W. A. Tilden, F.R.S., and Prof. W. R. Dunstan, F.R.S.; the Linnean Society by Prof. G. B. Howes, F.R.S.; the Meteorological Society by Mr. F. C. Bayard; the Society of Chemical Industry by Mr. A. Smetham.

NOTES.

PROF. W. A. HERDMAN, F.R.S., sailed for Ceylon on December 26, 1901, to undertake for the Government an investigation of the pearl oyster fisheries of the Gulf of Manaar. He is accompanied by a first-rate assistant, and in Ceylon the inspector of the fisheries and his staff will cooperate and provide boats and divers. A suitable steamer for dredging and trawling will be placed at Prof. Herdman's disposal by the Government of Ceylon; and the necessary gear and apparatus for collecting and observational work, and for biological experiments, have been sent out in advance. We understand that Prof. Herdman has arranged to take samples of the plankton throughout the voyage to Ceylon, and to launch current-floats at particular parts of the course.

A PUBLIC meeting was held on Friday last at Cromarty, the birthplace of Hugh Miller, for the purpose of discussing what steps should be taken to celebrate next year the centenary of his birth. Sir Archibald Geikie wrote stating that he heartily sympathised with the object of the meeting and wished all success to the movement which it would initiate. After discussion, a committee was appointed to further a scheme for the erection in Cromarty of a Miller Institute, comprising a library and museum.

IT is proposed to commemorate, on June 15 next, the two hundredth anniversary of the death of G. E. Rumphius, the celebrated naturalist who spent his life in investigation at Amboina, one of the Molucca Islands. The authorities of the Colonial Museum at Haarlem have made arrangements for the preparation of a Rumphius medal, copies of which can be obtained in silver or bronze. Subscribers for the commemorative medals who send their names to the president or secretary of the Haarlem Museum before March 1 will receive a copy of a memorial volume to be published in honour of Rumphius.

THE death is announced of Mr. H. G. Madan, senior Fellow of Queen's College, Oxford, and for twenty years head of the science department at Eton College.

WE learn from *Science* that Mr. Alexander Agassiz, accompanied by Mr. W. McM. Woodworth, has undertaken an expedition to the Maldive Islands in the Indian Ocean, in order to study the coral formations. A steamboat for this purpose has been chartered at Ceylon.

DR. SVEN HEDIN, the Swedish explorer, who recently arrived at Ladakh from Central Asia, has sent a telegram to King Oscar announcing that he has made an extremely important journey through all Tibet, disguised as a pilgrim, with two followers. On approaching Lhasa they were recognised and captured, but were well treated by order of the Dalai Lama. A second attempt was opposed by 500 Tibetan soldiers. Dr. Hedin's collections were lost, with almost the whole caravan, but his notes were saved.

THE Board of Agriculture has appointed a committee to investigate the two diseases of sheep known as "braxy" and "louping-ill." The members of the committee are Prof. Hamilton, of Aberdeen University, Mr. J. McI. McCall, assistant veterinary officer to the Board, Mr. E. J. Wheler, agent to the Duke of Northumberland, with Mr. R. B. Greig, lecturer on agriculture, &c., to the Durham College of Science at Newcastle-on-Tyne, as secretary and demonstrator. The mortality from the diseases in question is a cause of very great loss to the sheep-farming industry in Scotland, probably amounting to between a quarter and half a million of money annually, or even more.

DR. HANS REUSCH, Director of the Geological Survey of Norway, directs attention, in a recent issue of *Naturen*, to the fact that the rock at Moskogaissa mine, 750 m. above the sea, in Lyngen, Arctic Norway, is covered with a frozen moraine from 18 to 20 metres thick. On a previous occasion Dr.

Reusch found permanent ice in a bog near Vadsö. At lower altitudes, where the soil lets the water through, no permanent ice occurs. Still, at Karasjok the ground is not far from a state of permanent freezing. The mean temperature of the place is $-2{\cdot}6°$ C. As it is difficult to dig graves in the ground during winter time, a large hole is made in the autumn and bodies are put into it as people die. The bodies soon freeze hard and sometimes they do not thaw in the spring, when they are buried. It has been found that bodies have remained frozen so long as ten years after their burial.

To the December number of *The Zoologist* Mr. G. Renshaw contributes an interesting article on the extinct blaauwbok (*Hippotragus leucophoeus*) of South Africa. This handsome species, an ally of the sable antelope and the roan antelope, was, it appears, always scarce and local, one of its refuges being the mountains between Swellendam and Algoa Bay, where the last specimens were shot in 1800. Its colour was bluish-grey, with pure white under-parts. The author records sixteen specimens known to have been preserved, but only a few of these appear to be still extant. One skin is now in the museum at Vienna, a second in Stockholm, a third in Upsala, a fourth in Paris and a fifth in Leyden. Our own Natural History Museum possesses a couple of frontlets with horns believed to belong to the blaauwbok. In the same journal Mr. H. E. Howard comments on the marked increase in the numbers of the starling and the hawfinch which has taken place of late years in this country. Writing from Hampshire, he observes of the latter species:—"Fifteen years ago I rarely saw this bird; five years ago small parties of five and six were not at all uncommon; and during the winter now I frequently see as many as a dozen under one yew. This year eight pairs nested within half a mile of my house."

A FEW details concerning the plans of the Scottish Antarctic Expedition are given in the *Dundee Advertiser* of December 25, 1901. The expedition will be directed by Mr. W. S. Bruce, who has had some experience in the Antarctic, and has been engaged in scientific work within the Arctic circle on several occasions. Scientific research will be the chief object of the expedition, and Mr. Bruce will be accompanied by at least seven men of scientific training, who will be engaged with different subjects of investigation. The ship which has been secured for the expedition is a Norwegian whaler called the *Hecla*, a wooden ship of similar dimensions and build to some of the Dundee whalers. The ship will be ready about the beginning of August next and will go for a trial spin for three weeks in the Atlantic for the purpose of testing her gear and instruments before her final departure for the Antarctic, when she will make for the Falkland Islands for the purpose of taking on coal and provisions, and then strike for the field of operations in the Weddell Sea—a region of the Antarctic about which nothing is known, and which has only once been visited by an exploring party, some eighty years ago. This region promises to yield results of very great scientific value, and a thorough knowledge of it would go a long way to solve many of the problems connected with the Antarctic. The Weddell Sea is situated directly between the sphere of operations of the German expedition on the one hand, and the Swedish expedition on the other; so that the results of all three expeditions will be of advantage to each other on their return home. Details of cooperation or division of labour were carefully planned and arranged between the respective leaders of the Scottish, German and Swedish expeditions before the departure of the two latter. It is expected that the expedition will be absent more than a year at least, and possibly much longer if the necessary funds are forthcoming. The whole of the money subscribed towards the expedition has been given by Scotsmen only, and as the scientific staff and ship's officers and crew will also belong to the northern side of the Border, the whole project is a truly Scottish one.

M. C. GUTTON has described in the *Journal de Physique* for December some experiments tending to show that the wavelength of Hertzian oscillations is the same in water as in air. The corresponding property for castor oil has been previously proved by M. Blondlot; the present result is interesting, as in the case of water the imperfect conductivity gives rise to absorption of the oscillations.

A NEW method of determining the principal indices of refraction of a crystal by means of the critical angle has been investigated by M. Cornu, and the results are briefly detailed in the *Bulletin* of the French Physical Society, 172. The method is based on M. Cornu's geometric investigations of the total reflection at the surface of a crystal, and has been applied to calculate the indices of refraction in tartaric acid. In this substance the angle of conical refraction amounts to 4°, and interesting lantern experiments are described on the conical refraction of a crystal 23 mm. thick as well as on ordinary crystals of commercial tartaric acid immersed in clove oil.

THE design and construction of fly-wheels for slow-speed engines for electric lighting and traction purposes are discussed by Mr. A. Marshall Downie in the *Transactions* of the Scotch Institution of Engineers and Shipbuilders, xlv. 1. By projecting the indicator diagrams of the several cylinders of compound engines the author obtains curves representing the fluctuations in the combined crank efforts at different points of the revolution. From an examination of these fluctuations the author arrives at the conclusion that a good average value for the energy necessary to be stored in fly-wheels for electric lighting purposes is 2·9 foot-tons per electric horse-power, and in traction-plant 4 foot-tons.

FROM observations described by Prof Geitel in the *Physikalische Zeitschrift*, iii. 4, it appears that atmospheric air is itself capable of inducing radio-activity. When a mass of air remains shut up for a long time in a cellar or cave, Prof. Geitel finds that its electric conductivity increases to a maximum. There are three hypotheses possible, namely, that the exposed substances were themselves radio-active, that traces of radio-active substances were present in the neighbourhood, or that the air itself is the origin of the radio-activity. From experiments made with a kite at a considerable height above the ground and from other evidence, Prof. Geitel favours the view that the third is the most likely hypothesis.

DR. FOVEAU DE COURMELLES and M. G. Trouvé describe, in the *Bulletin* of the French Physical Society, certain new apparatus for the study of different light-rays of considerable intensity. These are based chiefly on the use of parabolic reflectors and other concentrators, and screens for filtering out the heat-waves or separating those of any required portion of the spectrum. The authors have applied their apparatus to the cure of lupus, tuberculosis, and other diseases at the Hospital of St. Louis in Paris, without producing any burning or blisters, the source of energy being an arc lamp of 10 amperes radiating for 10 minutes at 70 watts, or 8 amperes at 85 watts, while with Finsen's apparatus 75 to 80 amperes for 80 minutes are necessary.

THE arrangements for photochronographic observations in the physiological laboratory of Moscow University form the subject of a paper by Prof. L. Morokhowetz and Drs. A. Samojloff and A. Judin, published by the Imperial University Press. The room used for these observations is divided into four parts, one of which is described as a "monster camera," being a dark room in which the photographs can be exposed and watched during

the exposure. Among the apparatus used is a pendulum photochronograph, in which the pendulum carries a sensitive plate and is provided with a contrivance for releasing it at will and fixing it at the end of each half-oscillation. The papers are illustrated by photographs of the curves of different vowel sounds, taken in the laboratory.

THE problem of the perfectly irresistible body impinging on a perfectly impenetrable obstacle is scarcely more paradoxical than Poinsot's problem of a rigid body having two points fixed, when it is proposed to calculate the actual reactions and not merely the sum of the reactions along the line joining the points. The *Bulletin* of the Belgian Academy contains reports on a paper by M. Ferron, in which that author endeavours to overcome the indeterminateness of the problem by replacing the force Z at any point in the body by its components in the lines joining its point of application to the two fixed points. One of the referees of the paper, M. Ch. Lagrange, objects to the principle of transmission of force being applied in this case, but he does not hesitate to apply it in a paper of his own, in which he seeks to prove that each of the reactions is equal to $\frac{1}{2}$ Z.

A THEORY of progressive taxation, capable of being represented by simple mathematical formulæ, is discussed by Mr. G. Cassel in the *Economic Journal* for December. It is pointed out that the same results that are obtained by means of a graduated income-tax can equally well or better be effected by levying a tax at a constant rate per cent. and allowing suitable deductions to be exempted from taxation. Moreover, if a tax is to produce "equal sacrifices" the amount which should be exempted from taxation should be larger for large than for small incomes, as the cost of living consistent with efficiency increases with the amount of income to be earned. Mr. Cassel's proposal is based on the supposition of a "minimum of subsistence" representing the income exempt from taxation, and a "maximum of subsistence" representing the cost of living consistent with efficiency in earning an infinite income. The amount deducted for subsistence and the rate of taxation are then represented by formulæ of the form known to mathematicians as "homographic transformations."

IN the use of the wet and dry bulb thermometer for determining the pressure of aqueous vapour in air, considerable uncertainty is introduced by the presence of a constant which varies according to the conditions under which the thermometers are placed. The extremes are represented by August's formula, which supposes the air round the bulbs to be constantly changing, and Maxwell and Stefan's result, which is calculated on the hypothesis that the water on the bulb is evaporating and its vapour diffusing into an infinite mass of quiescent air. Signor G. Guglielmo, writing in the *Atti dei Lincei*, x. 9, now proposes to eliminate the arbitrary constant by the use of a *third* thermometer, the bulb of which is wetted by an aqueous solution the vapour tension of which differs considerably from that of pure water. In this way a further equation is obtained and the unknown constant is eliminated. Some preliminary experiments are quoted showing the efficacy of the method. The difficulties of applying it arise from the change in concentration of the solution caused by evaporation, and the consequent uncertainty as to its latent heat. But could not a second volatile liquid be substituted for the saline solution?

AT a recent meeting of the Meteorological Society of Mauritius, the secretary, Mr. T. F. Claxton, read an interesting paper on the objects for which that Society was established, in the year 1851. These were, chiefly:—To provide for regular observations in Mauritius and its Dependencies (Rodrigues, Seychelles, Diego Garcia, &c.), the establishment of a permanent observatory, and the collection and tabulation of observations taken in the Indian Ocean. Some of these objects have been successfully carried out, as shown by the *Transactions* of the Society and the annual reports of the Royal Alfred Observatory. The establishment of this observatory (in 1874) was perhaps the most important achievement of the Society; it is supported entirely from Government funds, and the director has always been the secretary of the Society. Every ship visiting the island is boarded and permission requested to extract observations for the construction of charts. Cyclone tracks of the Indian Ocean were published in 1891 and are of great use to navigators at the present time, and an important work has recently been commenced, viz. the tabulation into 5° squares of all the information collected from the log-books of vessels that have traversed the Indian Ocean since 1854, with the view of constructing a meteorological atlas of the south Indian Ocean; this will doubtless be of much practical use to sailors. Unfortunately, there has been a steady decrease in the number of vessels trading with Mauritius, from 787 in the year 1878 to 283 in 1900, so that the construction of daily synoptic weather charts begun by Dr. Meldrum about 1860 has had to be discontinued, except during cyclone weather.

THE Imperial Department of Agriculture for the West Indies has issued a second, and revised, edition of Mr. Maxwell-Lefroy's pamphlet on "The General Treatment of Insect Pests." Another of the pamphlet series, No. 11, "Hints for School Gardens," by the technical assistant, Mr. William G. Freeman, has just been published. It deals, in simple language, with the most elementary principles of agriculture, taking box and pot cultivation as the starting point for school work, and going on to gardening—growing vegetables and flowers and experimenting with manures. Mr. Freeman has written a useful handbook, which should be studied by teachers with Mr. Watts's "Nature Teaching" recently noticed here.

IN his annual report on the Antigua Botanic Station, Mr. W. N. Sands, the curator, gives a complete summary of the work for the year ending March 31, 1901. The most interesting feature of the report is a detailed account of an experiment designed to ascertain what a small plot of land about the size of a peasant garden or negro ground would produce in provisions, if properly managed and arranged. The usual method adopted by the peasantry is to grow one or two crops only, and for which they have to wait about five months for a return, which is often poor, and then selling out for a few shillings, often pence. At the Botanic Station a patch 1/10 acre in extent, and overgrown with grass, was taken in hand, and, having been duly cleared, forked and manured, nineteen varieties of vegetables were sown or planted at various periods. In due time such of them as matured were reaped, and sold locally. The sum realised for the produce of the patch was 2*l*. 15*s*., the expenditure having been 1*l*. 15*s*. 3*d*. Of the latter sum, however, 1*l*. 4*s*. 8*d*. was expended on labour, which would not come out of the peasant's pocket, as he would attend to his garden in his spare time. By the exercise of a little intelligence, therefore, a peasant could make a profit of 2*l*. 4*s*. 5*d*. out of 1/10 acre of land in nine months.

THE most important paper in the *Transactions* of the Hull Scientific and Field Naturalists' Club for 1901 is one by Messrs. F. W. Mills and R. H. Philip on the diatoms of the Hull neighbourhood. It is illustrated by no less than sixteen plates, drawn by the first-named author.

THE October issue of the *Bulletin* of the Cracow Academy of Sciences contains an important article, by M. Godlewski, on the development of muscular tissue in mammals; and a second, by M. Przesmycki, on certain protozoans parasitic in rotifers. Both are elaborately illustrated.

M. ARMAND GAUTIER contributes to the *Revue Générale des Sciences* of December 15, 1901, an article entitled "Les Mécanismes moléculaires de la Variation des Races et des Espèces," taking as his text the experiments in hybridisation made of late years with the French and American species of vine.

MANY animals have popular names which have been derived from their cries. Prof. T. D A. Cockerell writes to suggest that this is also the case with the donkey, the "don" representing the inspiratory and "key" the expiratory sound. Most dictionaries describe the word, which is of comparatively recent origin, as signifying a little dun animal, from dun and the diminutive term—key, but the grounds upon which this derivation is based are not easy to find.

TO the *Proceedings* of the Washington Academy of Sciences (vol. iii. pp. 577–600) Dr. C. H. Merriam contributes a paper on the various local forms of the puma. It has long been recognised by naturalists that an animal with such an extensive range must be divisible into a considerable number of geographical races; but Dr. Merriam goes further than this, and considers that several of these ought to rank as species. If such a course were generally adopted it would be advisable to make the puma the type of a genus. Dr. Merriam remarks that these animals are very subject to cleft palate.

WE have received reprints of a series of articles from the November issue of the *Journal* of the Quekett Microscopical Club. In one, Mr. W. Wesche describes a new male rotifer from Hampstead Heath, while Mr. C. F. Rousselet treats of a new species of the same group in a second. In a third, Mr. D. J. Scourfield has notes on the manner in which the fresh-water polyp hydra suspends itself from the surface-film of water. In a note on "red rain dust" from Australia, Mr. G. H. Karop shows that, in addition to mineral matter, the substance in question contains a certain number of diatoms, and a percentage of what appear to be sponge-spicules.

WE have received the first number of a new journal, *The Emu*, published at Melbourne, which is to be the organ of the Australasian Ornithologists' Union. In the introductory notice the editor discusses the question whether the name of the bird from which the journal takes its title should be spelt "emu" or "emeu." We are told that the native pronunciation is *emyoo*; and if this be so, according to accepted ideas of transliteration *emeu* makes a nearer approximation to the original than *emu*, which would now be pronounced *emoo*. The number before us contains some interesting articles and a couple of excellent photographs of breeding colonies of gannets and frigate-birds. The new venture ought to have a successful future.

A SHORT time ago we noticed a communication by Prof. T. H. Morgan on the regeneration of limbs and other parts of the body in animals. The same investigator contributes to the December issue of the *American Naturalist* an article on regeneration in the egg, embryo and adult. Within the last few years it has been ascertained that portions of an embryo, or even of an unsegmented egg, have the power of producing a new organism; but it has not been determined whether regeneration of parts of an adult organism and of pieces of an egg are similar or identical processes. The author answers the question in the affirmative, but denies that there is any analogy between this process and the natural reparation of a broken crystal. Nevertheless, he connects this recuperative process in animals with a kind of organic "polarity."

THE Christmas number of the *Stock-keeper* is largely devoted to illustrations and descriptions of famous specimens of the more popular breeds of domesticated dogs. The editor, it appears, offered a number of prizes for the best photographs of well-bred dogs by amateurs, and the successful pictures, together with many others, have been reproduced as photogravures in the present issue. Attention is called in an article on the results of the competition to the importance of preserving photographs of the modern breeds of dogs, and regret is expressed that we possess no such records of their predecessors. It may be added that it would be of the highest importance if arrangements could be made for taking photographs of dogs (and other domesticated animals) from above as well as from in front and from the sides.

IN their fifteenth annual report the Liverpool Marine Biological Committee refer with satisfaction to the arrangement concluded with the Government of the Isle of Man whereby they will in future enjoy much larger laboratory accommodation, and, jointly with a committee of the Tynwald Court, be responsible for the conduct of a large aquarium and fish-hatchery. A detailed statement as to how this important change in the position of the committee has been brought about is given, while its probable effects on their work are also mentioned. The greatness of the change may be realised when we state that it involves the moving of the present biological station to a larger and more convenient site on the other side of the bay. The work accomplished during the past year appears to have been large and of a satisfactory nature. The report contains an excellent popular guide to the Port Erin Aquarium, illustrated by figures of a large number of its denizens. Prof. Herdman is to be congratulated on the continued progress of the institutions the interest of which he has so much at heart.

A NOTICE of the collections recently bequeathed by the late Mr. Philip Crowley to the natural history branch of the British Museum appeared a few days ago in *The Times*. A very important portion of the bequest is the collection of eggs, from which 15,200 specimens have been added to the series previously possessed by the Museum. Among the gems in the Crowley cabinet are an egg of the great auk and one of the extinct pied Labrador duck. Both these specimens were acquired by Mr. Crowley from Canon Tristram. The great auk's egg is one of the last "batch" despatched, in 1844, from Iceland to Denmark. The two specimens in the Museum previous to this addition were both cracked and in otherwise poor condition. An interesting item in the collection is the number of clutches of eggs of various species of birds with a cuckoo's egg among them. The Crowley collection has added about 15 per cent. to the species of birds represented by their eggs in the Museum, the increase being especially marked in Australian forms, in which the national collection was previously weak. In addition to eggs, the Museum also acquired a large series of invertebrates, especially butterflies, from the Crowley collection. The article concludes with a reference to the valuable series of specimens from the Uganda district recently presented to the Museum by Sir Harry Johnston. Apart from the okapi and five-horned giraffe, this collection includes a valuable series of fishes from Lakes Victoria and Barengo—the first ever obtained from these waters.

A CATALOGUE of the Mediterranean algæ is commenced by Prof. Francesco Ardissone in the Lombardy *Rendiconti*, xxxiv. 17. The first part deals with Rhodophyceæ, and the author has decided, for stated reasons, to adopt Agardh's classification.

THREE additional volumes of the Yale University Bicentennial Publications have been received. Two contain studies from the chemical laboratory of the Sheffield Technical School, edited by Prof. H. L. Wells, and the third is a text-book on vector analysis, for the use of students of mathematics and

physics, founded upon the lectures of Prof. J. Willard Gibbs by Dr. E. B. Wilson. The volumes can be obtained in London from Mr. Edward Arnold.

THE kinematograph is now so frequently employed to reproduce the characteristics of moving objects and scenes that everyone is familiar with its pictures. But twenty years ago, when Mr. Muybridge projected before an audience at the Royal Institution a series of moving pictures illustrating animal locomotion, the results were regarded as veritable photographic triumphs. Since then photography has been utilised in the analysis of motions of many animate and inanimate objects, but Mr. Muybridge's collection of pictures is still the standard work on the various changes which take place in the disposition of the limbs and body of common animals during motion. A cheap edition (price 20*s.*) of the plates illustrating "The Human Figure in Motion" has been published by Messrs. Chapman and Hall, and will doubtless be appreciated by artists and students of anatomy who are unable to study the elaborate work in which the pictures originally appeared.

THE "Annuaire" of the French Bureau des Longitudes is a wonderful repertory of statistical and other information requiring frequent revision if it is to represent existing conditions of knowledge. In the volume for 1902, received a few days ago, we notice that all the dates are expressed in mean civil time, reckoned continuously from 0 hour to 24 hours, and beginning at midnight. The catalogue of minor planets has been brought up to October 2, 1901. M. E. Levasseur brings the statistics of the population of Europe up to the end of October last; and the magnetic elements of the chief places in France are given for the epoch January 1, 1902. As in previous years, there are articles on subjects of wide scientific interest. To the present "Annuaire" M. H. Poincaré contributes an article on telegraphy without intervening wires; M. A. Cornu writes on polyphase currents; M. E. Guyou on the application of the decimal division of the quadrant of a circle to navigation; and M. J. Janssen on the establishment and work of the observatory on the summit of Mont Blanc.

THE as yet unanswered question concerning the source and mode of production of the free electricities, which appear on the separation of two heterogeneous bodies which have been in contact, is the subject of an interesting paper by O. Knoblauch in the last number of the *Zeitschrift für physikalische Chemie.* Seventy-five different substances of various characters were brought into contact with plates of platinum, paraffin, sulphur, and glass, and the positive or negative character of the charge received by the plate on separation was in each case determined. By the assumption of an absorbed film of water on the surfaces of these different bodies, the author finds it possible by application of well-known principles of the ionic theory to account for the character of the charge received by the one substance after it has been in contact with a second.

THE additions to the Zoological Society's Gardens during the past fortnight include a Vervet Monkey (*Cercopithecus lalandii*) from South Africa, presented by Captain B. Head; ten Crab-eating Raccoons (*Didelphys cancrivorus*) from South America, a Gangetic Trionyx (*Trionyx gangeticus*) from the Ganges, fifteen Tigrine Frogs (*Rana tigrina*) from India, deposited; a Crimson-breasted Barbet (*Xantholoema haematocephalus*) from India, a Variegated Sheldrake (*Tadorna variegata*) from New Zealand, purchased; a Campbell's Monkey (*Cercopithecus campbelli*) from West Africa, presented by Mr. F. R. Paxman; a Green Monkey (*Cercopithecus callitrichus*) from West Africa, presented by Dr. Gray; a Bonnet Monkey (*Macacus sinicus*) from India, presented by Mr. D. Justice.

OUR ASTRONOMICAL COLUMN.

ASTRONOMICAL OCCURRENCES IN JANUARY.

Jan. 3. Epoch of January meteoric shower (radiant 230° + 53°).
5. 11h. 28m. Minimum of Algol (β Persei).
8. 8h. 17m. Minimum of Algol (β Persei).
9. 10h. Saturn in conjunction with the sun.
9. 15h. Venus at greatest brilliancy.
11. 5h. 5m. Minimum of Algol (β Persei).
12. 4h. 17m. to 5h. 27m. Moon occults c' Capricorni (mag. 5·2).
12. 18h. Venus in conjunction with moon. Venus 3° 8′ S.
13. 6h. 23m. to 7h. 1m. Moon occults κ Aquarii (mag. 5·5).
15. Venus. Illuminated portion of disc = 0·218, Mars = 0·990.
15. 11h. Jupiter in conjunction with sun.
21. 8h. 15m. to 8h. 39m. Moon occults 71 Orionis (mag. 5·1).
22. 16h. 56m. to 17h. 28m. Moon occults 68 Geminorum (mag. 5·0).
24. 6h. 7m. to 7h. 1m. Moon occults κ Cancri (mag. 5.0).
24. 17h. 23m. to 18h. 0m. Moon occults ω Leonis (mag. 5·6).
26. 18h. 38m. to 19h. 30m. Moon occults p^5 Leonis (mag. 5·5).
27. 21h. Juno in conjunction with moon. Juno 1° 11′ N.
28. 9h. 59m. Minimum of Algol (β Persei).
31. 6h. 48m. Minimum of Algol (β Persei).

STARS NEAR NOVA PERSEI.—Prof. Ceraski reports in the *Astronomische Nachrichten* (Bd. 157, No. 3755) that on a photograph obtained on the night of 1899 January 30 there is a small star very near the position at present occupied by the Nova. Visual observations with a 15-inch telescope now fail to locate the star, and he asks astronomers with powerful instruments at their disposal to examine this region. The coordinates with respect to the Nova Persei are:—

$$\text{R.A.} = \alpha \text{ Nova} + 0^s{\cdot}31.$$
$$\text{Decl.} = \delta \text{ Nova} - 7''.$$

As estimated from the photograph, the star would be of about the 12th magnitude.

MAGNETIC OBSERVATIONS DURING TOTAL SOLAR ECLIPSE.—In the *Journal of Terrestrial Magnetism and Atmospheric Electricity* (vol. vi. pp. 123–143) reports are presented showing the details of observations of the magnetic declination, horizontal and vertical forces during the total solar eclipse of May 17–18, 1901. The stations employed for the determinations given in this issue were at Pola, Austria; Val Joyeux, France; Groningen University, Holland; De Bilt Observatory, near Utrecht; Flushing, Holland. Further reports will be published later, and the whole discussed with the object of investigating the perturbations due to extra-terrestrial causes.

THE TOTAL SOLAR ECLIPSE, MAY 18, 1901.—In *Popular Astronomy* for December, 1901, Prof. E. E. Barnard gives a long description of the preparation, equipment and preliminary experiments undertaken in connection with the last eclipse, and although the weather conditions prevented any positive results being obtained, the record of his methods of dealing with apparatus on such great scale—the plates used were 40 × 40 and 30 × 30 inches—will be of considerable interest and value to workers on future occasions.

NATAL OBSERVATORY REPORT FOR 1900.—The report recently issued by the Government Astronomer of Natal contains as a supplement the details of the observations at the various meteorological stations throughout the colony during the year 1900, with summaries. The returns of several stations are unavoidably incomplete in consequence of the unsettled state of the country.

The instruments, with the exception of the 8-inch Grubb equatorial refractor, are in good order. This instrument will, it is hoped, be shortly dismounted and thoroughly overhauled.

The system of time signals is now established over the colony and is working satisfactorily.

PRIZE AWARDS OF THE PARIS ACADEMY OF SCIENCES.

AT the annual meeting of the Academy of Sciences, held on December 16, 1901, the presidential address was given by M. Fouqué and the following prize awards were announced:—

Geometry.—M. Léonce Laugel is awarded the Francœur prize and M. Émile Borel the Poncelet prize.

Mechanics.—The extraordinary prize of six thousand francs is divided between M. Tissot for his work relating to the utilisation of wireless telegraphy in the Navy, and M. Marbec for his calculations on the strength of tubular boilers; M. Aimé Witz receives the Montyon prize, and M. Boulvin the Plumey prize for his applications of the entropy diagram to the steam engine. The Fourneyron prize, the subject proposed for which was the theoretical or experimental study of steam turbines, is not awarded.

Astronomy.—The Lalande prize to M. Thome, and the Valz prize to M. Charles André for his treatise on stellar astronomy.

Physics.—The La Caze prize is awarded to M. Curie for his work on radium and on piezo-electricity of crystals, the Gaston Planté prize to M. G. Boucherot, the Kastner-Boursalt prize to MM. H. Gall and de Montlaur for their electrochemical work.

Statistics.—The Montyon prize for statistics is given to M. G. Baudran for his work on tuberculosis in the Department of the Oise, a very honourable mention being accorded to the memoir of MM. Delobel, Lebrun and Cozette on the statistics of contagious diseases of animals in France, and to M. Lowenthal.

Chemistry.—The Jecker prize is divided between MM. Moureu, Simon and Léo Vignon, MM. Wyrouboff and Verneuil receiving the La Caze prize for their researches on the rare metals.

Mineralogy and Geology.—The Delesse prize is awarded to M. Gaston Vasseur for his work on the classification of the Tertiary strata in the west and south-west of France.

Physical Geography.—The Gay prize is divided between MM. Franchet and Saint-Yves.

Botany.—MM. Matruchot and Molliard receive the Bordin prize for their work on the influence of the external conditions on the protoplasm and nucleus in plants, M. Karl E. Hirn the Desmazières prize, M. Mazé the Montagne prize for his researches on the mechanism of the fixation of nitrogen by the Leguminosæ, M. Ferdinand Debray the de la Fons-Mélicocq prize, and M. N. Patouillard the Thore prize for his taxonomic essay on the families and genera of the Hymenomycetes.

Anatomy and Zoology.—The grand prize of the Physical Sciences is awarded to M. Maupas for his two memoirs on the biology and the origin of the sexual elements in Nematods, and the Savigny prize to MM. Jules Bonnier and Ch. Pérez for their exploration of the Red Sea and the Persian Gulf.

Medicine and Surgery.—The Montyon prize is divided between MM. Buffard and Schneider, Lignières, and Claude and Balthazard, the Barbier prize between MM. Moreigne, Tissier, and Goyon, the Breant prize in equal parts between MM. Jules Courmont and V. Montagard, Weil, and Levaditi; M. René le Fur receives the Godard prize, M. Gley the Mége prize, whilst the Bellion prize is divided between MM. Landouzy and G. Brouardel, and M. Sauton, very honourable mentions being accorded to M. Razou and M. Pégurier. The Lallemand prize is divided between MM. Catois, J. C. Roux and J. Lépine, MM. F. Bernheim and A. Comte receiving very honourable mention. M. Catrin receives the Baron Larrey prize for his work on mental alienation in the Army, an honourable mention being accorded to MM. Tostivint and Remlinger for their memoir on the comparative pathology of the European and Arabian races.

Physiology.—The Montyon prize for experimental physiology is awarded to M. Marcel Mirande, M. Bonniot being accorded an honourable mention, the Pourat prize to M. Tissot for his researches on the cooling due to muscular contraction, the La Caze prize to M. Charpentier, the Philipeaux prize being divided between MM. L. Camus and M. Moussu.

General Prizes.—The Lavoisier medal is awarded to M. Emil Fischer, professor of chemistry at the University of Berlin, correspondant of the Academy, for the whole of his works and in particular for those relating to the syntheses of the sugars. The Montyon prize (unhealthy trades) is divided between MM. Albert Dormoy and L. Vaillard, M. Halphen receiving an encouragement. M. Baubigny receives the Wilde prize for his work on atomic weights, MM. Fosse and Grignard the Cahours prize (in equal parts), P. Stanislas Chevalier the Tchihatchef prize for meteorological and astronomical studies in China, M. Gabriel Lippmann the Jean Reynaud prize, M. F. Foureau the Leconte prize for his scientific explorations in southern Algeria, M. Foureau the Janssen gold medal, and MM. N. Villatte, E. Verlet-Hanus and A. P. de Chambrun silver gilt medals for their work in the Sahara, M. Gabriel Kœnigs the Petit D'Ormoy prize for his researches in geometry and mechanics, M. Bouvier the Petit D'Ormoy prize (natural sciences), M. Guichard the Saintour prize, M. A. Ponsot the Gegner prize, M. Frémont the Trémont prize.

The Baron de Joest prize is divided between MM. Verschaffel and Saint-Blancat for their astronomical work, the prize founded by Mme. la Marquise de Laplace being given to M. Japiot, and that founded by M. Félix Rivot to MM. Pellarin, Ott, Japiot and Guillaume.

ELECTRIC WAVES.

THE annual meeting of the German Association of Men of Science and Physicians was held last autumn in Hamburg. It is twenty-five years since the Association last met in the birthplace of Heinrich Hertz, who was then a young man of nineteen, not yet entered upon the active period of his life, which ended by his death in 1894, and which, though so short, was yet so great and full of usefulness. It fell, therefore, to the lot of Prof. Ernst Lecher to deliver this address[1] in memory of Hertz and to review the further development, which has taken place since his death, of his greatest work, the experimental proof of the existence of electric waves.

It is, indeed, a long chain of events, as Hertz himself expressed it, to which the discovery of electric waves belongs, one event linking itself into another, the whole forming perhaps the most noble and convincing proof that our modern methods of scientific thought and research are true and exact. Prof. Lecher gives an interesting sketch of this in the pamphlet before us. The first link in the chain was forged by Faraday. Until his time the scientific world was dominated by the old Newtonian ideas of force acting at a distance, an idea which seems to us now, on close examination, to be manifestly absurd. It required, however, the genius of Faraday to break loose from this line of thought and to perceive that a medium is necessary in order that one body may exert a force upon another; and to the eye of Faraday the whole of space became filled with lines and tubes of force, real changes of condition in the intervening media, which, although invisible, were as clear to him as the objects acted upon themselves. The way was thus paved for Maxwell, who collected these ideas in his really magic formulæ of the electrodynamical theory of light. According to Maxwell there are electric currents in insulators, these being of the nature of displacement currents. Although these currents are of very short duration, yet they must have like magnetic and inductive effects to the ordinary currents in a conductor. If, now, a displacement current vibrates backwards and forwards, then in a neighbouring insulator displacement currents will be induced, and so forth; a transversal wave-motion is thus propagated until it is absorbed by induction in a conductor and transformed into heat. On calculating the velocity of this wave propagation it was found that two quantities appeared in the result—the dielectric coefficient and the permeability. The square of the velocity is equal to the reciprocal value of the product of these two values. It was found, however, that whole powers of this value were always appearing in different branches of the theory of electricity, and, most extraordinarily to say, the value was always found to be equal to the velocity of light. Maxwell, therefore, came to the theoretical conclusion in 1865 that an electromagnetic wave must travel in an insulator, *e.g.* in air or vacuum, with the velocity of light. But not only the velocity, concluded Maxwell, should be the same, but also the geometrical and other properties must be equal; a ray of light was therefore a series of electric waves, light was electricity. These ideas, immediately after their enunciation by Maxwell, did not meet with any great acceptance, and an experimental proof of their accuracy was looked upon as being altogether out of the question. This feeling was even shared by Hertz himself, for in his description of his classical experiment where, by means of a

[1] Ueber die Entdeckung der elektrischen Wellen durch H. Hertz und die weitere Entwicklung dieses Gebietes. (Leipzig: Johann Ambrosius Barth.

spark gap in a loop of wire, he showed the sparks induced by the electric waves at a distance of ten metres from the transmitter, he said: "It appears impossible, nearly nonsensical, that these sparks should be visible, but in a perfectly dark room they *are* visible."

Since the death of Hertz it can hardly be said that another link in the chain of development has been forged. Our knowledge and study of electric waves have spread and expanded enormously, and the practical utilisation of the same is seen in the modern wireless telegraphy. The possibility, as Marconi has shown, of already sending messages without the use of wires for a distance of 300 kilometres is the direct result of the labours of Hertz. From a theoretical standpoint the work of the many investigators of the last few years has simply increased the burden of proof that the fundamental ideas of the electrodynamical theory are correct. Many points, however, yet remain to be cleared up. In the domain of the ether itself very few difficulties have been encountered. Very different has been the case when the ether pure and simple has been left and the theory and ideas extended to ordinary bodies and materials. Chief among these difficulties must be mentioned the phenomena of anomalous absorption and dispersion, and the relative interaction of mass and ether is to-day one of the most perplexing and yet enticing fields of scientific work. Perhaps here we are, though it is not mentioned in the pamphlet, just commencing the forging of yet an entirely new link, which will be seen in the full development of the corpuscle and electron theories, and the explanation of the many at present very strange phenomena included under these names. Besides being a very interesting address, this booklet would be very useful in serving as an index to the many investigations which have been made and published in this branch of science.

C. C. G.

THE CIVILISATIONS OF HALLSTATT AND LA TENE.[1]

THE publications of the Prehistoric Commission of the Imperial Academy of Science in Vienna, in their present form, date from the year 1887, when it was resolved to discontinue the practice of publishing their reports as integral parts of the *Transactions* of the Academy. The primary object of this commission was to prosecute palæo-ethnographical investigations throughout the Austrian dominions, taking special care that the necessary excavations would be conducted in a thoroughly scientific manner. Since 1887 five parts, in all 363 pages, in quarto, with plates and numerous illustrations in the text, have been issued, giving on an average only twenty-eight pages per annum—a rate of progress which, *primâ facie*, does not suggest that such researches are advancing with rapid strides in that part of Europe. Looking, however, at the contents of the various papers and reports, which range over the whole field of prehistoric archæology, I am constrained to say that, in forming a fair estimate of the archæological value of the labours of the commissioners, we must be guided by quality and not by quantity.

The part now before me (No. 5) contains two papers, one by Dr. Moritz Hoernes and the other by Mr. Josef Szombathy, both officials in the prehistoric department of the K.K. Naturhist. Hofsmuseum in Vienna. Dr. Hoernes describes five different groups of antiquities from the vicinity of Vukovar, on the south side of the Danube and not far from the great bend which the river makes in changing its course from south to east. One group consists of the débris of a settlement of the Stone Age, two—one being a hoard—are of the Bronze Age, while the remaining two are respectively interments of the Hallstatt period and of Slavish times (eleventh or twelfth century). The first station, which bears the name Vučedol, is considered of some importance inasmuch as its relics, especially the pottery, illustrate the evolution of ornament; and so the author discusses at some length the points of resemblance and difference between them and those of a number of other analogous stations, such as Butmir (Bosnia), Tordos (Transylvania), Sarvas, near Essegg (Slavonia), the lake-dwellings of Laibach Moor, &c. But as Dr. Hoernes' opinions on these matters are already known, or at any rate accessible, to archæologists through his great work on the history of prehistoric art in Europe ("Urgeschichte der bildenden Kunst in Europa," Wien, 1898). I shall pass on to the next paper, which, having an important bearing on the development of the early Iron Age in Europe, is of some consequence to British archæologists who may be desirous to trace the late Celtic remains of their own country to their proper source.

Mr. Szombathy's valuable monograph, "Das Grabfeld zu Idria bei Bača," takes the form of a report on excavations made, in 1886 and 1887, in forty-seven graves discovered in the valley of the Idria in the Julian Alps. The little cemetery, occupying an area of 5 to 10 metres in breadth and 30 metres in length, is situated on the right bank of the river some 20 metres above the river-bed and about an hour's walk to the south-east of the great necropolis of Santa Lucia—one of the most famous landmarks of the Hallstatt period in Europe. These graves had, on the average, a depth of one metre and a breadth and length of 50 to 80 centimetres; and all of them, with the exception of two, contained interments after cremation. They are numbered in the order in which they were excavated, but in the report they are described in chronological sequence beginning with the oldest, *i.e.* the middle Hallstatt period (about 600 B.C.). As this sequence comes down to late Roman times we have in the contents of the cemetery of Idria a remarkable evolutionary series of remains, extending over a period of nearly 1000 years. The successive stages of civilisation disclosed by the investigation, together with the number of graves assigned to each, are as follows:—Middle Hallstatt represented by 1 grave, late Hallstatt by 13, early La Tène by 2, middle La Tène by 13, late La Tène by 7, early Roman by 8, and late Roman by 2.

Mr. Szombathy's description of the relics, with 212 illustrations in the text, is a model of precision and brevity, without any lack of essential details, and therefore admits of no curtailment. The following remarks will, however, give readers some idea of their salient features.

Ornaments.—Among this class the fibulæ are the most interesting. One or two, of the boat-shaped type, having a long, straight foot, belong to the middle Hallstatt period. The Certosa fibula and its contemporary the cross-bow fibula are respectively represented by fourteen and three specimens. The La Tène fibulæ—early, middle and late forms—are numerous, and well worth careful study by those who have not acquired precise notions of the progressive stages thus designated. Five hinge fibulæ, peculiar to Roman remains, complete the list. Among the early La Tène group there are two very remarkable, if not unique, specimens. These are ornamented with amber beads placed in pairs on five pins projecting from the upper surface of the bow and attached to a bronze wire which, in a succession of small, graceful coils, follows the curve of the bow from head to foot. The middle La Tène specimens have the recurved foot ending in a circular expansion, which appears to have contained a setting of some kind of enamel. Iron fibulæ are scarce. The other objects of personal ornament consist of earrings, studs, finger-rings (one with three twists), bracelets with one or more coils, glass beads and torques.

Vessels.—Bronze caldrons and situlæ with movable handles, round or flat bottoms, and bulging, slanting or upright sides, are well represented. Two bronze dishes, one of the milk-plate type ($5\frac{1}{2}$ inches wide and $3\frac{3}{4}$ inches deep) and the other a small bowl with a ring-handle, have *graffiti* inscriptions on the outside of their rims, said to be in Venetic or old North Etruscan alphabet. A small bronze colander is perforated in such a manner as to form a geometrical pattern consisting of a central rosette surrounded by a fret border. Pottery is not abundant, and only a shallow dish, one or two jars with handles, and a conical vase with expanded base and slightly contracted mouth are figured.

Military Accoutrements.—A bronze helmet, with a projecting rim and central ridge, has an inscription in Roman characters scratched on it which reads *Protemus.*—There are also two iron helmets said to be of Roman workmanship. Among the weapons are a characteristic La Tène sword and sheath, both made of iron. Two other iron blades, also with their sheaths, are supposed to be like the Roman gladius. The iron blade in both specimens is separated from the grip (only the long tang of which now remains) by a circular guard of bronze. The sheaths were imperfect, but they appear to have been made of an iron frame, with panels of bronze and some non-durable material probably wood. There are also several spearheads, a knife-dagger still in its iron sheath and some fragments of shields showing conical bosses—all made of iron.

Industrial remains.—In this category are to be placed a

[1] "Mittheilungen der Prähistorischen Commission der K. Akademie der Wissenschaften in Wien." (Band i., No. 5, 1901.)

varied assortment of iron objects, such as knives, chisels, axes with flanges on one or both sides, axe-hammers with transverse sockets, scythes and sickles very similar to those from Oppidum La Tène, buckles, shears, shovels, ploughshares and coulters, the central portion of a bridle-bit, &c.

A bronze statuette.—One of the late Hallstatt graves contained a bronze figure of a beardless man, 12 centimetres in height. The body is clad in a closely-fitting tunic with a prominent girdle, leaving the neck, forearms and legs exposed. On the left arm is an armlet, on the left leg an anklet, and on the head a helmet. The bare feet rest on a small round pedestal. The gaze is directed to the palm of the upraised right hand, while the left arm is bent sidewards as if the half-closed fist were grasping the handle of an upright spear.

One of the most novel features of the cemetery was the proportionately large number of agricultural and domestic implements which it contained. While analogous cemeteries in other localities, such as the neighbouring necropolis of Santa Lucia, have yielded an endless array of objects of personal adornment, as well as others intended exclusively for votive purposes, here at Idria the grave-goods consisted of utensils, implements, weapons, tools and ornaments actually used in everyday life. Mr. Szombathy, however, observes that this peculiarity was more noticeable in the interments of the later half of the period during which the cemetery was in use.

Another equally noteworthy feature was that objects of different periods were not unfrequently found in the same grave—a fact accounted for by the tendency to continue old customs in secluded mountain valleys, such as that of Idria. This overlapping of different culture periods complicates, to some extent, the task of delineating the successive phases of the early Iron Age civilisation.

As to the racial question, Mr. Szombathy speaks by no means dogmatically. The earlier grave-goods indicate a civilisation so like that of Santa Lucia that its founders were probably of the Illyrian stock; but whether the same people continued in the Idria valley during the intrusion into it of the later Celtic and Roman culture-elements there is no evidence to show. Possibly the deciphering of the inscriptions on the bronzes, of which there are three or four, may help to solve the problem.

The frequency with which the generic expressions "Hallstatt" and "La Tène" are now used in the archæological literature of Europe renders it essential for British antiquaries to acquire precise ideas of the culture-elements represented by them. For the origin of the word "Hallstatt" we have to go back to the investigation of a cemetery in a small valley of the Noric Alps in the vicinity of Lake Hallstatt, and for that of "La Tène" to the well-known station of that name at the north end of Lake Neuchâtel. Subsequently these terms were used to designate similar remains found in widely-separated districts, just in the same way as the term "Mycenæan" is no longer restricted to the discoveries at Mycenæ. Practical researches have now greatly extended the culture-elements, both in number and types, which have to be classified under Hallstatt and La Tène, and it has often been mooted whether a better nomenclature could not be devised. I do not think it would now be advisable to make any change in this respect. What, however, is urgently required with regard to these terminal links in the development of the Iron Age in Europe is an authoritative work dealing with the essential characteristics of the relics discovered within their respective archæological areas. For records of the rich finds made in Central Europe since the appearance of "Das Grabfeld von Hallstatt" by v. Sacken, and in the cemeteries of Glasinac and Jezerine in Bosnia, as well as in those of the Istrian peninsula and the valley of the Po, we have to hunt in the *Transactions* of so many societies that they are, practically, inaccessible to all but a few specialists. Knowing the competency of Austrian archæologists for executing such a work, and the ample resources, by way of illustrations, at their command, I trust this suggestion will not remain fruitless.

ROBERT MUNRO.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

THE difficulty in connection with Mr. Carnegie's offer to found a National University (see p. 164) has been solved by the donor's arranging to convert into Government bonds the ten million dollars' worth of United States Steel Corporation bonds, the acceptance of which was an obstacle to the adoption of the scheme.

OUR national deficiencies in regard to provision for higher scientific and technical education are obvious to all who take the trouble to inquire into the matter. For many years men of science have been watching with a feeling akin to envy the opportunities provided for scientific instruction and investigation by foreign nations, and comparing them with the elementary efforts at technical education here. The facts which have been given in these columns week after week have made our readers familiar with existing conditions of technical education; and it is impossible not to be dismayed at the country's prospects in the industrial wars of the future when the inadequate way in which our industrial leaders are trained is understood. A pamphlet just published by the Association of Technical Institutions, giving a comparison of technical education at home and abroad, again brings the subject before the attention of the public. In the matter of buildings and equipment for the highest kinds of technical work we are still far behind Germany, Switzerland and America. Two diagrams published in Nature in 1898 (vol. lviii. p. 54) show clearly how Continental institutions for instruction and research work in technical or applied science are provided on a scale which vastly exceeds ours both as regards areas of sites and areas of buildings. Both these diagrams are reproduced in the pamphlet just mentioned, and also those which

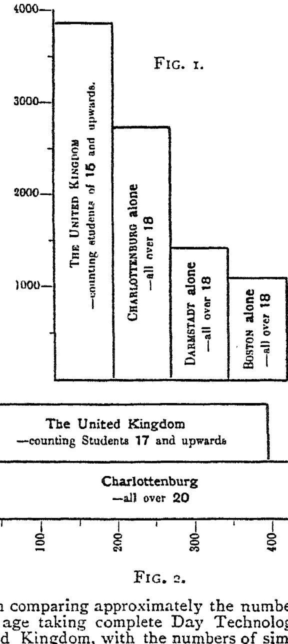

FIG. 1.

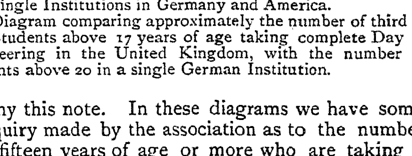

FIG. 2.

FIG. 1.—Diagram comparing approximately the number of Students above 15 years of age taking complete Day Technological Courses in the whole United Kingdom, with the numbers of similar Students above 18 in single Institutions in Germany and America.

FIG. 2.—Diagram comparing approximately the number of third and fourth year Students above 17 years of age taking complete Day Courses in Engineering in the United Kingdom, with the number of similar Students above 20 in a single German Institution.

accompany this note. In these diagrams we have some results of an inquiry made by the association as to the number of day students fifteen years of age or more who are taking complete regular day technological courses of not less than twenty hours a week. Statistics were obtained from Universities, University Colleges, technical schools and all similar institutions where day technological courses are given. The results of the inquiry show that in comparison with other countries our attempts at technical education are utterly futile. In the whole country there are only 555 third-year students of technology satisfying the conditions described, and 113 fourth-year students. The total number of third-year students in engineering is only 347, and of fourth-year students 52, and this number is only obtained by counting students who begin their studies at the immature age of fifteen. As the accompanying diagram (Fig. 1) shows, there are more than two-thirds as many regular day students above eighteen years of age at the Charlottenburg Technical High School, Berlin, as there are above fifteen years of age taking

complete day technological courses in the whole of the United Kingdom. If only day students of technology more than eighteen years of age are considered, there are less in our country than in any large technical institution in Germany or America, as indicated in Fig. 2. With facts like these to consider, the future of our country cannot be contemplated without misgiving. When will our political leaders take up the subject of secondary and technical education seriously, and insist upon proper provision being made for it by greatly increased funds from national and local sources? The apathy displayed in regard to technical training by both employers and employed is largely due to the drifting policy of the Government and the sacrifice of future interests to present expediency.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, December 5, 1901.—"Preliminary Account of the Prothallium of Phylloglossum." By A. P. W. Thomas, M.A., F.L.S., University College, Auckland, N.Z. Communicated by Prof. G. B. Howes, F.R.S.

The sporophyte generation of *P. Drummondii* is a small plant, growing from a tuber, which forms a tuft of a few cylindrical tapering leaves. The tuber is apparently comparable to the protocorm of *Lycopodium cernuum*, except that it is repeated annually on the formation of a new protocorm. The prothallia have been obtained amongst the parent plants, and very special conditions, which are not of regular annual occurrence, are necessary for germination of the spores, the most important being the presence of a fungus with which the prothallium lives symbiotically, like that of the Lycopods. One of the simplest prothallia observed consisted of an oval tuber below, with a simple cylindrical shaft with rounded apex, akin to that of the oldest prothallium of *L. cernuum* described by Treub. In older prothallia the crown is commonly separated by a slight constriction from the much enlarged body, which bears the embryo on one side. Below this swollen part the body contracts to a cylindrical shaft, which passes downwards and swells out again to terminate in the primary tubercle, from which more especially rhizoids are produced.

The prothallia are monœcious, and the archegonial necks, which vary from two to twenty in number, are a conspicuous feature of the crown. The oosphere lies at a little depth below the surface layer, and the antheridia are sunk in the crown, with their enclosed cavities elongated at right-angles to the surface. The sex-organs would seem to resemble those of *L. cernuum* more closely than those of any other species of Lycopodium.

Studied by means of microtomic sections, the development appears to be also much like that of *L. cernuum*. The embryo grows obliquely downwards and outwards, the part near the archegonial venter is the foot, and at the opposite end are the stem-apex and leaf, the tip of the leaf being the first part of the embryo to appear outside the prothallium. Immediately on escaping from the prothallium the embryo forms a protocorm, apparently in the same manner that the adult plant forms its annual tuber. The pedicel of the tuber elongates downwards until the latter is placed at a safe depth. In the meantime the leaf grows up, and although no root-formation has been observed during the first year, rhizoids may be developed on the pedicel and protocorm. The leaf becomes green even before it escapes from the prothallium, and as soon as it reaches a little above the soil stomata are formed, and a slender strand of tracheids in the centre. The first protophyll has the structure of a small leaf as produced in later years, and the later development of the sporophyte appears to be slow, the plant coming up in many cases a second and a third year with only a single leaf. A young prothallium was found quite colourless, except for a yellow tinge at the upper end, while two others still without sex-organs bore but scanty chloroplasts. But never was there a fully developed prothallium which was not green above. The prothallium is distinctly of Lycopod type, on the whole most nearly resembling that of *L. cernuum*, except that it lacks the leaf-like assimilatory lobes of this, and the simplicity of structure favours the view that Phylloglossum is a primitive form of Lycopod. It is recognised as a permanently embryonic form, but the simplicity of structure of the mature saprophyte does not necessarily prove it to be a primitive form of the Lycopodiaceous phylum.

Branching occurs in two ways. The spike or strobilus occasionally branches, and the branching always takes place above the lowest sporophyll, sometimes at the base of the spike or even near the apex of the strobilus. Even when the strobilus forks there is no transition of form between sporophyll and protophyll, and such leaves as have been observed on the peduncle some distance below the rest of the strobilus have always been of sporophyll type. Twenty was the largest number of protophylls found on a plant, but there is never a transition between protophylls and sporophylls. The view is entertained that the former may have arisen from the differentiation of the lower region of a sporogonium or its homologue, in which this region had acquired sterilised tissues, and that the sporophylls arose from the upper fertile region of the sporogonium. There appears to be no connection between the number of protophylls and reproduction by spores. The formation of two new tubers is common, and these may be found on opposite sides of the plant in a manner favourable to dispersion.

Phylloglossum is not semi-aquatic. It may grow upon a hill-top and as well upon a slope, and it was never found in actual swamp. There is little evidence that it owes its simplicity to reduction, and it is regarded as possibly the most primitive of existing Pteridophytes, while the simple character of the gametophyte and comparison of the mature sporophyte with the embryo of *Lycopodium cernuum* favour the view that it is the most primitive of existing Lycopodinæ.

The author has finished and despatched to London an elaborate and fully illustrated memoir upon this most important organism.

December 12, 1901.—"Contributions to the Chemistry of Chlorophyll. No VIII. Changes undergone by Chlorophyll in passing through the Bodies of Animals." By Edward Schunck, F.R.S.

The conclusions to which the experiments described lead are summarised as follows:—

(1) The fæces of animals supplied with green vegetable food only—such at least as have so far been examined—contain no chlorophyll, but in its place substances which must be supposed to be derivatives of chlorophyll, formed partly by the action of acids on the chlorophyll of the food, partly by some agency to which the latter is subjected in its passage through the body.

(2) Of these substances, one seems to be identical with phylloxanthin, a well-known product of decomposition of chlorophyll. Another is a substance of well-marked properties, nearly resembling, but not identical with, phyllocyanin. It has not, so far as the author's experience goes, been hitherto observed as a result of any process of decomposition to which chlorophyll has been subjected outside the animal body. He considers it as a body *sui generis*, characterised by its fine purplish-blue colour and its brilliant metallic lustre. The existence of other products in addition to these two is possible. On one occasion, indeed, a definite crystalline substance was obtained, which seemed to be peculiar, but that it was in any way connected with chlorophyll could not with certainty be maintained.

Royal Astronomical Society, December 13, 1901.—Dr. J. W. L. Glaisher, president, in the chair.—The secretary read a paper, by Prof. S. C. Chandler, on Sir G. Airy's reflex zenith tube. The history of this instrument had passed through various phases—in the beginning of great hopes, later of grievous perplexity, and finally of severe disappointment. All attempts to obtain parallax or the constant of aberration produced quite discordant results, and the observations had at last been practically abandoned. But Dr. Chandler now showed that these anomalous results were due to the relative motions of the earth's axes of rotation and figure discovered by him some ten years ago, and that the zenith-tube observations, so far from being useless, had provided us with an invaluable record of these phenomena. An analytical proof of these statements was given in the paper.—Prof. R. A. Sampson gave an account of the original MSS. of the late J. C. Adams on the perturbations of Uranus between the dates 1841 and 1846. It was shown that Adams made no less than six different solutions of the problem in this period, and that the first, completed in 1843, was much more complete than had been supposed.—Prof. Turner read a paper on a simple method of accurate surveying with an ordinary camera, in which he showed that results of great accuracy could be rapidly obtained by the photographic method.—Mr. Hinks gave a paper on the accuracy of measures on photographs,

especially in reference to recent papers on the subject by M. Lœwy and Mr. H. C. Plummer.—Other papers were taken as read.

Zoological Society, December 17, 1901.—Prof. G. B. Howes, F.R.S., vice-president, in the chair.—A communication was read from Mr. G. Metcalfe, M.A., of New South Wales, concerning the reproduction of the duckbill (*Ornithorhynchus anatinus*). The author stated that he was of opinion, after many years' observation of the animal, that the duckbill was viviparous and that the young were not, as was generally supposed, hatched from the eggs after they had been deposited.—Dr. C. I. Forsyth Major exhibited the skull of a fossil aquatic musteline animal, *Enhydrictis galictodes*, gen. et sp. nov., from the Pleistocene ossiferous breccia of the island of Sardinia, which he stated had affinities with both the neotropical Galictis and with the genus Trochictis from the Middle Miocene of European deposits.—Mr. J. S. Budgett read a paper (illustrated with lantern slides) on the structure of the larval Polypterus. His observations confirmed the belief that the Crossopterygians were a very generalised group of vertebrata, and he concluded that the particulars of structure in which other more recent groups agreed with these ancient types were probably of a primitive rather than of a secondary nature.—Mr. L. A. Borradaile read a paper on the spawn and young of a polychæte worm of the genus Marphysa from Ceylon, allied to, or identical with, *Marphysa teretiuscula*, Schmarda.—Dr. P. Chalmers Mitchell read a paper on the anatomy of gruiform birds, with special reference to the correlation of anatomical characters. The communication was based on dissections of birds belonging to the Rallidæ, Gruinæ, Araminæ, Psophiinæ, Dicholophidæ, Otididæ, Rhinochetidæ, Eurypygidæ and Heliornithidæ, the material consisting chiefly of birds that had lived in the Society's gardens.—Prof. F. G. Parsons read the first portion of a paper, prepared by himself and Prof. B. C. A. Windle, F.R.S., on the muscles of the Ungulata. This part dealt with the muscles of the head, neck and fore-limbs of these mammals.—Mr. F. E. Beddard, F.R.S., gave an account of the minute structures in the spermatophores of the earthworms of the genus Benhamia.—Mr. G. A. Boulenger, F.R.S., read some further notes on the African batrachians which he had recently described under the names *Trichobatrachus robustus* and *Gampsosteonyx batesi*. A communication was read from Dr. A. G. Butler consisting of a list of thirty species of butterflies of which specimens were contained in a collection sent home by Major A. H. Cowie, R.E., from St. Lucia, West Indies. One of the species was new to science, and was described under the name of *Cystineura cowiana*.

PARIS.

Academy of Sciences, December 23, 1901.—M. Fouqué in the chair.—On the periods of double integrals, by M. Émile Picard.—On the cultivation of clover on soils deprived of lime, by MM. P. P. Dehérain and E. Demoussy. The experiments described furnish two interesting examples of the influence of inoculation and of the medium on the growth of Leguminosæ; the clover grows in the soil of Brittany whenever lime and phosphates are used, that is, as soon as the medium becomes favourable to its vegetation; it remains poor, on the other hand, in a heath soil, in spite of the creation of a favourable medium, because garden earth does not carry the necessary bacteria.—Remarks by M. Bouquet de la Grye on the work done by the third general conference of weights and measures.—Remarks by M. E. Guyou on the annual of the Bureau des Longitudes for 1902.—On the measurement of the meridian of France by Méchain at the end of the eighteenth century, by M. G. Bigourdan. If to the measurements of Méchain, which formed the basis of the metric system, the corrections of Delambre are applied, the results are brought more nearly into line with the recent observations of Perrier.—On the observation of the annular eclipse of the sun of November 11, 1901, by M. A. de la Baume-Pluvinel. The observations, which were partly photographic and partly ocular, were made in Lower Egypt. Owing to the early hour at which the eclipse took place the ocular observations were the most satisfactory. One point to which especial attention was directed was the examination of the spectrum of the sun in the neighbourhood of the edge of the moon. A thickening of some of the Fraunhofer lines here would indicate the existence round the moon of a gaseous atmosphere capable of producing a sensible absorption. But no evidence of such a thickening could be obtained either from the negatives or from the direct observations, thus confirming the absence of a sensible atmosphere round the moon.—Remarks on the note of M. de la Baume-Pluvinel, by M. J. Janssen.—The calculation of real roots of equations, by M. A. Pellet.—The progressive calculation of the integrals of certain differential systems, by M. Riquier.—On the separation and calculation of the real roots of equations, by M. Raoul Perrin.—On the numbers e and π and transcendental equations, by M. Edmond Maillet.—On the most general motion of a solid body which possesses two degrees of freedom round a fixed point, by M. René de Saussure.—The laws of electrical energy, by M. E. Carvallo. A criticism of the two laws enunciated by Maxwell.—On a new application of optical observations to the study of diffusion, by M. J. Thovert. The two solutions are superposed in a plane-sided box and the deviation of a horizontal light ray measured. The deviation is proportional to the rate of change of the concentration with the vertical ordinate. The diffusion of a solution of sodium chloride into water was measured by this method and the results were found to be in accord with the theoretical expression.—Contribution to the study of Geissler tubes in a magnetic field, by M. H. Pellat.—The cooling power and conductivity of air, by M. P. Compan. An experimental determination of the velocity of cooling of a blackened copper ball in dry air at different pressures. The velocity of cooling could be expressed by the formula of Dulong and Petit for pressures between 760 mm. and 15 mm.; for pressures below this the rate of cooling falls off much more rapidly than would correspond to this formula.—Observation of an antisolar corona on the Puy de Dôme, by M. Bernard Brunhes.—On a petroleum ether thermometer, by M. L. Baudin. By the use of a light petroleum ether possessing a density of 0·647 at 15° C., a thermometer can be constructed which does not solidify at the temperature of liquid air, and which can be used to measure temperatures down to that point. It was graduated at four fixed points, the boiling points of oxygen, nitrous oxide, methyl chloride and the melting point of ice.—On the dilution constant of saline solutions, by M. Albert Colson.—On metallic strontium and its hydride, by M. Guntz. Strontium can be prepared by the electrolysis of an aqueous solution of strontium chloride with a mercury kathode and then driving off the mercury from the amalgam by very cautious heating. Heated in hydrogen at a moderately high temperature it forms a hydride, fusible at a red heat of the composition SrH_2. The properties of strontium resemble those of barium, except that strontium does not appear to form an ammonium compound with liquid ammonia.—On the plurality of the blue oxides of molybdenum, by M. G. Bailhache.—On methylene chlorobenzoate and dibenzoate, by M. Marcel Descudé. These two compounds are obtained simultaneously by the action of benzoyl chloride upon trioxymethylene in the presence of zinc chloride.—On the hyposulphites of the aromatic amines, by M. A. Wahl.—Some new reactions of the organo-metallic derivatives. Synthesis of ketones, by M. E. E. Blaise. Magnesium organo-derivatives react with nitriles to form compounds immediately decomposable by water with the formation of ketones. The reaction appears to be gen.ral, and details are given of the preparation of ethyl-*o*-tolyl ketone, benzyl-*n*-propyl ketone, benzylisoamyl ketone, *o*-methyldesoxybenzoin, *n*-butyl-*p*-tolyl ketone, *n*-propyl-*p*-tolyl ketone, *n*-propylisoamyl ketone, ethyl-propyl ketone and ethylphenyl ketone. The semicarbazides of these ketones were also prepared, and their melting points are given.—On the basic properties of oxygen and its quadrivalency in the xanthene series, by M. R. Fosse.—The action of normal propyl and butyl alcohols upon their sodio-derivatives; the synthesis of dipropyl and dibutyl alcohols, by M. Marcel Guerbet.—The study of fermentation amyl alcohol, by M. G. Bemont. Fermentation amyl alcohol boils at 131° and gives on oxidation a valeric acid boiling at 175°, probably methyl-ethylacetic acid.—On the variation of the kidney and its excretion in fowls fed with meat, by M. F. Houssay. Under a meat diet the urea excreted is nearly three times the amount with a grain diet, and the kidney would also appear to increase in weight by about one-third.—A new contribution to the search for the typhoid bacillus, by M. R. Cambier. The author has shown in a previous note that the typhoid bacillus can make its way fairly readily through the walls of a porcelain filter immersed in a nutrient broth. The *Bacillus coli communis*, which is also very mobile, can grow through the walls in a

similar manner. In the present paper an account is given of an attempt to diminish the mobility of the latter bacillus by the addition of alkali and common salt. Particulars are given of an application of these facts to the determination of the presence of the typhoid bacillus in drinking water.—Study of the variations of the organic matter during germination, by M. G. André.—A method for separating glutamic acid and leucine by means of hydrochloric acid gas, by M. A. Étard.—On the bluing of certain fungi, by M. Gabriel Bertrand. On breaking certain fungi of the genus Boletus, the tissue exposed to the air takes on a fine transient blue colour. It is shown that this effect depends on six different factors: the substance boletol, the oxygen of the air, laccase, manganese, water and a metal belonging to the series of the alkalis or alkaline earths.—On the root of Iboga and ibogine, by MM. Lambert and Heckel. A physiological study of the active principle of Iboga. The alkaloid ibogine possesses anæsthetic properties resembling those of cocaine.—An attempt at the measurement of cytological activity, by M. Rémy Saint-Loup.—Observations on the root nodosities in the Leguminosæ, by M. Émil Laurent.—The causes of sterility in peaty soils, by M. J. Dumont.—A new case of variation in the vine following mixed grafting, by M. A. Jurie.—On the aging of the embryo in the Graminaceæ, by M. Edmond Gain.—On the refracting globules of the chlorophyllian parenchyma of leaves, by M. Louis Petit.—Considerations on the sexuality of certain yeasts, by M. A. Guilliermond.—Proof of the existence of the Trias in Greece. The stratigraphical position of the Cheli limestone, by MM. L. Cayeux and Ed. Ardaillon.—Observations on the synclinal of Amilie-les-Bains, by MM. Léon Bertrand and O. Mengel. The dislocation in the quartz at Éveaux and at Saint-Maurice (Creuse), by M. L. de Launay.—On a new Miocene layer in the interior of Corsica, by M. E. Maury.—Some new proofs relating to the contamination of the springs in the chalk in France, by M. Martel. The case is considered of streams which flow above ground for some distance and become polluted and then disappear into fissures of the chalk, and after undergoing a certain amount of filtration reappear in the form of springs. Confirmation is given of the possibility of danger from this source.—On the project of crossing the Sahara by balloon, by M. Deburaux.

NEW SOUTH WALES.

Royal Society, November 6, 1901.—Mr. H. C. Russell, C.M.G., F.R.S., president, in the chair.—The following gentlemen were elected hon. members of the Society:—Prof. J. W. Judd, C.B., F.R.S., Prof. Simon Newcomb, and Sir Benjamin Baker, K.C.M.G., F.R.S.—The Clarke memorial medal for 1901 was awarded to Mr. Edward John Eyre, Walreddon Manor, Tavistock, England, for his exploring work.—The Thurrawal language, by Mr. R. H. Mathews. In this paper the author describes the structure of the native speech of the aborigines of the region between Jervis Bay and Port Hacking. An appendix exhibits the elements of some other dialects adjoining the Thurrawal tribes on the north and west, the whole concluding with an extensive vocabulary.—Note on the sesquiterpene of Eucalyptus oils, by Mr. Henry G. Smith. In this paper the author showed that a sesquiterpene occurs in many Eucalyptus oils and that it is this constituent that gives the pink coloration to Eucalyptus oil when testing for eucalyptol with phosphoric acid.—Current papers, No. 6, by Mr. H. C. Russell, C.M.G., F.R.S. In the year November 1900 to November 1901, 130 current papers were received, and these form the basis of the present paper. In this list there was a marked increase on the tracks Sydney to Canada and United States. Previously very little was known of the drift of bottle papers in that sea; but during this year an appreciable increase of interest has been manifested in the current papers found amongst the islands. These show very clearly the presence of a very rapid current near the equator, somewhat similar to that in the Indian Ocean. For instance, current paper 598 made daily a drift near Fiji of 11·1 miles per day; near Gilbert Island, No. 671 travelled at the rate of 19·5 miles per day; and near Phœnix Island the current paper No. 674 travelled 16·8 miles per day; and so on. At first it seemed that current papers aggregate in certain months, but upon the monthly papers which have been received in five years there is not much to support the idea. But there is good reason to believe that the current paper is affected by the wind as well as by the currents, and that strong persistent winds alter the landing places of current papers.

DIARY OF SOCIETIES.

THURSDAY, JANUARY 2.

RÖNTGEN SOCIETY, at 8.30.—On the Function of an Auxiliary Electrode in X-Ray Bulbs: C. E. S. Phillips.—On Radiography applied to Dental Surgery: Prosper H. Marsden.—Mr. H. W. Cox will demonstrate a New Method he has devised for exciting Several Tubes simultaneously from One Coil.

FRIDAY, JANUARY 3.

GEOLOGISTS' ASSOCIATION, at 8.—On the Waves of Sand and Snow: Dr. Vaughan Cornish.

MONDAY, JANUARY 6.

SOCIETY OF CHEMICAL INDUSTRY, at 8.—The Report of the Joint Arsenic Committee of the Society of Chemical Industry and of the Society of Public Analysts will be presented by the Chairman.—The Retarding Influence of Aldehydes on the Maturation of Spirits: Prof. J. T. Hewitt.

VICTORIA INSTITUTE, at 4.30.—Modifications in the idea of God, produced by Modern Thought and Scientific Discovery: Rev. Chancellor J. J. Lias.

WEDNESDAY, JANUARY 8.

SOCIETY OF ARTS, at 5.—Photography and its Applications, II. (Juvenile Lecture): Sir Henry Trueman Wood.

GEOLOGICAL SOCIETY, at 8.—A System of Glacier-Lakes in the Cleveland Hills: P. F. Kendall.—The Glaciation of Teesdale, Weardale and the Tyne Valley, and their Tributary Valleys: A. R. Dwerryhouse.

ROYAL GEOGRAPHICAL SOCIETY, at 4.30.—Waves: Dr. Vaughan Cornish.

THURSDAY, JANUARY 9.

MATHEMATICAL SOCIETY, at 5.30.—Non-uniform Convergence, and the Integration of Series: the President.—Network: S. Roberts, F.R.S.—On Quartic Curves with a Triple Point: A. B. Basset, F.R.S.

INSTITUTION OF ELECTRICAL ENGINEERS, at 8.—Discussion of the Technical Reports on the Institution Visit to Germany, 1901, by the Committees on Traction, Light and Power; Manufacturing, and Telegraphs and Telephones.

FRIDAY, JANUARY 10.

ROYAL ASTRONOMICAL SOCIETY, at 8.

MALACOLOGICAL SOCIETY, at 8.

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THURSDAY, JANUARY 9, 1902.

ANALYSIS OF MEMORY.

Memory: an Inductive Study. By F. W. Colegrove, Ph.D., D.D., Professor of Philosophy in the University of Washington. With an introduction by G. Stanley Hall, LL.D. Pp. xi + 369. (London: G. Bell and Sons. New York: Henry Holt and Co., 1901.) Price 6*s.* net.

THE title of this book—"An Inductive Study"—leads us to expect an exposition of fundamental and derivative generalities based on a logical arrangement of thoroughly criticised facts. Facts and generalities there are in plenty, but the criticism is not adequate, neither is the arrangement conspicuously logical. The result is that, in spite of Dr. Stanley Hall's commendation, the book as a whole leaves on one an impression of chapters loaded with detail yet not adding much to the scientific study of memory. Prof. Colegrove has taken great pains, but he has attempted too much in a small book, and his standpoint is neither frankly scientific nor frankly popular. In Chapter i.—"Historical Orientation"—he makes a rapid sweep from the Greeks to the moderns, indicating the transit from the unsystematic *aperçus* of the earlier schools to the positive methods of the later. The conception is good, but the space available makes even a tolerable sketch impossible. Even the characterisations given are sometimes more than doubtful. It is quite inaccurate, for instance, to say that in contrast with Kant's "masterly analysis of mind," "Reid, Stewart and Hamilton are wholly metaphysical" (p. 10). Then, the account of Bain's formula for the nervous seat of reproduced feelings—"the renewed feeling occupies the very same parts, and in the same manner, as the original feeling, and no other parts, nor in any other assignable manner"—becomes "mental impressions depend upon the renewal of the feeling which accompanies the same part and in the same manner as the original feeling" (p. 14), which is practically unintelligible. Badly done summaries are worse than none, and the above—which involves a fundamental doctrine—does not alone suffer by the compression. The references, however, are, as a rule, given; the student will therefore not be misled, but the general reader also would prefer accuracy in his "orientation."

In Chapter ii.—"Biological Orientation"—we have a mass of facts, partly anecdotal, about animal intelligence generally, instincts, habits, natural selection, memory and some other things. The purpose is to lead up to the general theory of "organic memory" (Hering) and "racial memory" (p. 89). We are left without any clear conception as to whether "racial memory" implies (*a*) cumulative use-inheritance (Spencer), or (*b*) selected variations (Weismann). The difference is said to be "in part a war of words" (p. 87). Possibly, but the words are of Sibylline importance. "Organic memories refer to the ability to conserve racial experiences by a congenital modification of the organism" (p. 90) leaves the question very much an open one, even if the wording were unexceptionable. The use made of "racial memory" and "organic memory" elsewhere makes one long to have Locke's onslaught on "innate ideas" written up to date.

In Chapter iii.—"Diseases of Memory"—Prof. Colegrove recapitulates familiar clinical facts regarding word-blindness, word-deafness and other forms of aphasia. He adds one or two striking records of traumatic loss of memory with gradual recovery (pp. 126 *et sqq.*), and illustrates the theory of "inhibition" amnesia. His general conclusion that Ribot's "law of regression" demands modification, if, indeed, it holds at all, is not borne out by the cases he records. There is as much difference between the physiological sequence in normal memory decay and the shattering due to gross lesions like cerebral hæmorrhage as there is between progressive muscular atrophy and a broken leg. To make the sporadic dissociations correlated with hæmorrhage illustrate the normal sub-involution of progressive senility requires much more minute evaluation of clinical facts than we get here. The work of M. Pierre Janet would have assisted Prof. Colegrove to what we mean, but he nowhere refers to Janet.

The next chapter—"Brain and Mind"—could not, perhaps, be avoided, but it should have been reduced. Prof. Colegrove, however, takes the "correct" attitude towards the metaphysical theories he mentions, namely, that they are not in the province of psychology. The formula of "genetic parallelism," which simply means that mind and body emerge together and develop together, and "functional interaction," which means that now the physical, now the psychical, is uppermost, may be accepted as a variant on the "double-faced unity" or "parallelism" theory; but in Chapter v. the mode of expounding this relationship frequently lapses, verbally if not in content, from its presuppositions. On p. 176, where it is held that (*a*) the "neural discharge" and (*b*) the "conscious element" may, each on occasion, "take the initiative," the language seems to imply that the "conscious element" is wholly divorced from any "neural discharge." This transit in terminology from physical to psychical and *vice versâ* is made again and again. The general result of the chapter is that there are "memories," not a "memory" (p. 198). This, however, is only to say that the various grades of the nervous system have each their appropriate variety of retentiveness and reproduction. In his exposition the author plays off "organic memory" against the more limited psychological "memory." He does not maintain much order in his sequence of "memories." Nor is his language always exact. That "muscular memories depend *chiefly* upon the nervous system" (p. 198) suggests a question that is not solved by the following sentence:—

> "By exercise a muscle acquires new power, which is due in part to a change in the muscles themselves, but such memories are associated with the nervous system. This is possible because the motor nerve terminates in the centre of the muscles and throws off branches in all directions" (p. 199).

There is not much "orientation" here. Prof. Colegrove would have profited by a more intensive study of the good "psychologies," which would have enabled him to use the matter of this chapter to more purpose.

In Chapter vi.—"Individual Memories"—we have the

only "inductive" effort in the book. The chapter contains a large number of moderately well-sifted facts. The author's *questionnaire* included 1658 persons of various ages and races. Some of the facts are valuable, but they are not so arranged as to elicit any striking generality. They are, indeed, like the "facts" of many other *questionnaires*, apt to be the bad observations of untrained observers. The minute study of a few cases would have been more fruitful of "inductions" than these somewhat content-less percentages of commonplace recollections. One reasonably looks for more from an "inductive" study than this on the question of "taking notes":—"There is a wide diversity of opinion as to how full notes a student should take, and almost all degrees of copiousness are indicated" (p. 270). The true inference is that most students are poor psychologists. The extremely varied suggestions for teaching a "boy to remember things *on time*" (p. 271) only show that practical pedagogy in America, as elsewhere, is more ready to punish the boy than to study his mind—punishment being as effective, on the average, as it is useless in some particular cases.

Chapter vii.—"Apperception and Association"—includes sections on recognition times, attention and interest. This chapter is one of the best in the book. The essence of Chapter viii.—"Pedagogical Applications"—is that good memory depends on attention and the attentive multiplication of associations. There is not much novelty.

Of the book as a whole, it must be said that it suffers, in every chapter, from a want of clear definition of terms and a clear analysis of the phenomena to be investigated. The references, however, are valuable and the bibliography is good. W. LESLIE MACKENZIE.

A LUNAR ROMANCE.

The First Men in the Moon. By H. G. Wells. Pp. 312. (London: George Newnes, 1901.) Price 6*s.*

IT is many years now since Jules Verne wrote his imaginary account of a journey to the moon. He supposed a party of three men enclosed in a projectile shot by a huge gun towards the moon, which they never reached; they fell back to earth and escaped in a marvellous manner to tell the tale. The work was imaginative enough to hold the attention, but full of scientific blunders and improbabilities of the most glaring character. Mr. Wells has produced a book of a very different character; he has made himself master of the little we know about the moon, and thought out the possibilities with the greatest care, and the result is a narrative which we will venture to say is not only as exciting to the average reader as Jules Verne's, but is full of interest to the scientific man. We do not mean that the astronomer is likely to learn any new facts from this *résumé*, for which he himself furnished the material; but he will be astonished to find how different the few scientific facts with which he is familiar look in the dress in which a skilful and imaginative writer can clothe them, and it is worth reading the book with minute care to see if one cannot catch Mr. Wells in any little scientific slip. Some writers are so easy to catch that the game is not worth playing; but Mr. Wells is a worthy opponent, and we are glad to see that his scientific rank has been recognised by the Royal Institution, who have invited him to lecture on January 24.

The visit to the moon is made possible by the discovery of a substance (cavorite) impervious to gravitation. This interesting property comes to cavorite only at a critical temperature (60° F.), after "the paste has been heated to a dull red glow in a stream of helium," and the suddenness with which the imperviousness arrives causes interesting events at first. When the new conditions are better realised, a glass sphere is built and covered with cavorite blinds which can be put up or down. When all are down the sphere is entirely free from attraction, and when any particular blind is up it is only attracted by the stars or planets seen in that direction. It is obvious that in these circumstances a comfortable voyage through space is manageable. The two occupants of the sphere journey to the moon and land upon it near the terminator, on a snow drift of frozen air. With sunrise they find that the air melts and evaporates, and there is enough for them to breathe, so that they emerge from the sphere. They find their weight a trivial matter and leap twenty or thirty yards at a step, and a wonderful fungus vegetation springs up before their eyes. In the exhilaration of exploring they lose their sphere and are thus thrown on their own resources. Presently they come across the Selenites, who emerge from the interior of the moon, where they have been spending the lunar night. The first to emerge are those herding the moon calves—great beasts 200 feet long, that browse in a vividly described and rather disgusting manner ("like stupendous slugs") on a speckled green mossy plant. The cowherd was a "mere ant" by comparison, and the intelligent Selenites generally turn out to be a sort of insect, varied physically in a grotesque manner at will. After various adventures in and on the moon, one of the voyagers recovers the sphere and gets back to earth; the other stays in the moon and sends messages by ethereal telegraphy describing it more fully; and the interest never flags throughout. Following similar writings, Mr. Wells sometimes allows himself a sly hint at terrestrial matters in describing lunar affairs. He describes a lunar artist thus (p. 302):—

"Love draw. No other thing. Hate all who not draw like him. Angry. Hate all who draw like him better. Hate most people. Hate all who not think all world for to draw."

And two pages on there is a similar burlesque description of a mathematician. It is even easier to see the point than to find the pun in the following:—

"And since the density of the moon is only three-fifths that of the earth, there can be nothing for it but that she is hollowed out by a great system of caverns. There was no necessity, said Sir Jabez Flap, F.R.S., that most entertaining exponent of the facetious side of the stars, that we should ever have gone to the moon to find out such easy inferences, and points the pun with an allusion to Gruyère . . ."

Of a book so full of unfamiliar things it is impossible to give a complete account. We will conclude this notice by heartily recommending the book to readers both scientific and unscientific, and by giving, with a triumph

not free from trepidation, an instance where we think Mr. Wells has been caught napping. When the cavorite blinds are closed and the sphere starts on its journey, he describes the curious effects of the absence of external gravitational attraction—all the material occupants of the sphere slowly collect in the interior by their *mutual* attractions, and there is no "up" or "down." Then a window is opened towards the moon and promptly everything gravitates towards the moon—the direction towards the moon is *down*wards, though the attraction is slight. Surely this is a slip? With bodies moving freely in space only the *differential* attraction would be felt, and this would be negligible compared with the mutual attraction of the occupants of the sphere. Even if it were not so small it could not act in the manner specified; its tendency would be to *separate* bodies (as in the case of the tides), not to bring them together, and thus a man near a "floor" would not fall towards it but would rise from it. But Mr. Wells is so wonderfully careful in general that we make this criticism with far less confidence than we should have felt in another case; we have an uneasy feeling that he may dexterously transfer the supposed slip from his account to ours.

A POPULAR WORK ON FISHES.

The Story of Fish Life. By W. P. Pycraft. Pp. 210. (London: G. Newnes, Ltd., 1901.) Price 1s.

THIS book, which is one of the shilling series published by Messrs. Newnes, is divided into fourteen chapters and illustrated by seventeen text figures and a frontispiece. Its contents are generally interesting and well arranged, but there is recognisable throughout its pages a leaning towards the racy and sensationally attractive, as, for example, in the method of dealing with the habits of the sword-fish and the feeding process generally. The mode of treatment is mainly physiological, the consideration of function preponderating over that of structure and development. Migration and "transformation" are in turn dealt with, the latter with a commendable emphasis of the part played in Nature's operations by "substitution."

Much attention is given to the skeletal organs and especially the teeth, and the author loses no opportunity of forcing home the lesson of the tooth-scale homology. The effort, however, is somewhat weakened by the assertion that, while fish-scales are (p. 29) typically "horny plates," they are (p. 31) in "the most primitive form" bony. The statement that the bony fin supports (p. 68) have been formed by the fusion of clusters of original "hair-like" rays is equally misleading; and in dealing with the terms expressive of types of tails, the author falls into the prevailing fallacy of applying them to the fins and not to the fishes themselves. In declaring that in the typical fish the dorsal fins are two in number, the fact that there may be three dorsals is ignored, it being implied (p. 58) that the codfish has but two. And error is further evident in the assertion that the adipose fin is "without supporting structures."

The mode of description is in places none too well chosen. Such declarations as that the "beauty" of the Cestracion's teeth is "entirely an accidental feature" and that in deglutition the "touch" of the swallowed food "signals" through the closed-up gullet to the nerves, are to be deprecated in a book of this kind; while a greater regard for the facts of morphology would have been in places acceptable, as in the mode of treatment of the types of so-called external gills. The existence of these in the Teleostei is denied; but while we excuse the non-allusion to those said to occur in the loaches, we consider it strange that, on a later page, the author incidentally refers to the African fishes obtained by Budgett, in which they have been proved to be abundantly present, without mentioning them. Nor is he more fortunate with his treatment of the internal gills and respiration, for nowhere in the book are the numerical limitations of the former even stated, nor is there mention of the "breathing valves," to which attention has but recently been redrawn.

In the aforenamed and other equally important matters, which, under the scheme adopted, should have found recognition in the book, the author is not up to date, as, for example, in his declaration that nothing is known of the chimæroid development. In the organological sections of the book sufficient use is never made of extremes of modification, such, for example, as those which render clear the real differences in the composition of the gills of the bony fishes and elasmobranchs, expressed in the terms pectino- and cysto-branchiæ. Particularly is this the case with the alleged distinctions between the two chief groups into which the author would divide the fishes as a whole. He gives, for this purpose, a classification, which is neither that of the author to whom he ascribes it nor an accurate statement of Huxley's observations, upon which it is based. "Hyostylic" and "autostylic" are the terms which denote the distinctive characters of his two great "branches," but the former is wrongly construed. Neither the author of the present work nor he whom he names acknowledge the condition termed by Huxley the *amphistylic*; and the author himself does not even mention the Notidanidæ, of which, alone among living fishes, it is diagnostic. These and the Port Jackson shark (which exhibits a marvellously transitional condition of the parts in question, for which alone a distinctive term might well be introduced) are not typically hyostylic. They are lower than those fishes which are. Without recognition of them and the amphistylic state Huxley's system cannot be adequately set forth. So important is this morphologically that advantage might be gained by associating the Notidanidæ with at least the Hydodonts and Pleuracanths among fossil forms, in a distinct order, in preference to the retention of the name "Ichthyotomi" for the latter alone. In the present case, in the non-recognition of these amphistylic forms and the absence of all reference to the hyomandibular element, the essential point is lost. In the spread of scientific knowledge, the more elementary that imparted the more precise should be the diagnoses employed.

There is a closing chapter on palæichthyology, of a very cursory type.

The present book is the second which the author has contributed to the series to which it belongs. The first, on "The Story of Bird Life," was in every way a success and as a popular treatise exemplary. Comparison shows that the striking differences between the two books are due to the fact that with the first of them alone the

author's knowledge was based on a thoroughly practical acquaintance with the animals with which he dealt. While we fully admit the difficulties of the task of compilation of the second, the present work, we regret we cannot recommend it with the confidence extended to its predecessor.

THE PROBLEM OF TRUTH.

Das Wahrheitsproblem unter Kulturphilosophischem Gesichtspunkt—Eine philosophische Skizze. Von Dr. Hermann Leser. Pp. iv + 90. (Leipzig: Dürr'sche Buchhandlung, 1901.) Price 2 marks.

THE author of this work is not a "jesting Pilate." His book contains rather a thorough discussion of the problem of truth in some of its widest issues. The standpoint is essentially Kantian, but with a difference. The question raised in the "Critique of Pure Reason" was, How are pure mathematical science and pure natural science possible?—in other words, on what principles can it be maintained that the ordinary experience of man *quâ* intellectual gives him truth? Dr. Leser contends that the problem should be stated more widely in the form, How is truth in general possible, the truth of all the higher spiritual life of man, of religion, morality, art, as well as science? And it is claimed for the work before us that, as compared with Kant's, it is more concrete in treatment, that it goes nearer the heart of things, and that while including and remaining true to Kant's results it gives a more satisfactory basis for future development.

The first part deals with a deepened idea of experience, for which the author employs the term "Kulturhistorische Erfahrung." By this he appears to mean the higher spiritual experience of the race as exhibited by history in such things as institutions, codes, systems, standards of judgment. In the development of this view, naturalism is subjected to some telling criticism. Finding nothing anywhere but "bare results, finer complications of natural process," naturalism would exclude all facts which do not coincide with, or cannot be reduced to, the facts of ordinary natural science. In dealing with the institutions in which the spiritual life has found expression, naturalism pays regard only to the crystallised form, not to the spiritual potencies which have been at work. It attaches exclusive value to what is genetically original, and denies, for example, the characteristic distinction between good and bad by deriving it from the distinction between the useful and the harmful. Such a psychogenetic method can never get beyond brutal actuality to norms or standards of judgment; it is only a transcendental method (the author maintains) which can disclose the organisation of "rulers and subjects," for example, the subordination of what is first in time to what is ideally fundamental.

The latter part of the book is concerned with the problem of truth from the new standpoint thus gained. It is pointed out that Kant replaced the old objectivity (supposed to exist entirely out of relation to a subject) by transcendental-subjectivity, than which no more secure objectivity can be found. This means that truth is to be found by "turning to one's own depths"; but if it is to be depths and not shallows, to be *transcendental*-subjectivity in the right sense and not bare subjectivity in the wrong sense, we must have recourse to "Kulturhistorische Erfahrung." It is only as experience is writ thus large that the potencies at work can be discovered. One of the chief of these potencies is personality. Personality Dr. Leser opposes on the one hand to bare individualism, and on the other to the equally bare disregard of the personal factor. The great man is neither the heaven-sent hero dear to the soul of a Carlyle nor the hollow pipe through which the "Zeitgeist" pours such music as it listeth. Or, as our author puts the latter point: "The man is more than the product of his time; planting himself on the original truth which he has found within him, it is he who first makes a new height attainable."

The work is not unnecessarily stiff. At times, perhaps, a little vagueness is felt, and the technical terms, as usual, can rarely be translated by single words. But his readers will doubtless welcome another book from this careful and suggestive writer. R. G. N.

OUR BOOK SHELF.

Catalogue of the Lepidoptera Phalaenae in the British Museum. Vol. iii. "Catalogue of the Arctiadæ (Arctianæ) and Agaristidæ in the Collection of the British Museum." By Sir George F. Hampson, Bart. Pp. xix + 690. Plates xxxvi–liv. (London: Printed by Order of the Trustees, 1901.)

FOR a long time after the study of exotic butterflies began to grow popular in England, that of moths continued to be much neglected, though moths, taken as a whole, are equally beautiful and far more numerous than the butterflies. But after the pathway had been smoothed by the useful, though much abused, catalogue of Walker, the works of Moore, Butler and Druce, and especially by Kirby's "Catalogue of Lepidoptera Heterocera: Sphinges and Bombyces," published in 1892, the Trustees of the British Museum decided to issue a general descriptive catalogue of the moths of the world, which bids fair to become one of the largest and most profusely illustrated of all their publications on natural history.

The work was entrusted to Sir George F. Hampson, and three thick volumes have already been issued. According to the table of families in vol. i. the author admits fifty-two, which, deducting seven for the butterflies, leaves forty-five for the moths, of which only the first three are monographed in the portion of the work already published, so that little more than the fringe of the subject has yet been touched. Of course some of these families only include a few species; but, on the other hand, there are several very much more extensive than the Arctiadæ, which alone fill up the greater part of vols. ii. and iii. The plates are published separately, and can be bought separately, a useful arrangement which will enable students who require an additional copy of the book for working purposes to purchase it without the additional and unnecessary cost of a duplicate set of coloured plates. In addition to these coloured plates, drawn by Mr. Horace Knight and chromolithographed by West, Newman and Co., the book is further illustrated by text-illustrations of types of genera, showing both the pattern and the most important generic details, and of these compound figures there are no less than 294 in vol. iii., in which 946 Arctianæ and 225 Agaristidæ are described, of which a considerable number are new species. At the end of the volume is a short list of species which the author has not been able to identify from the published descriptions. Should further information respecting these be forthcoming, we presume that

these, and any other casual omissions, will ultimately be dealt with in an appendix.

The next family to be monographed, if the author continues to follow the arrangement prefixed to his first volume, will be the extensive family of Noctuidæ, which alone may be expected to occupy several volumes.

To the technical portion of the book we can scarcely refer here in detail. It is a work that appeals mainly to specialists, and only specialists will be able to appreciate the time and labour involved in its production at their full value.

Psychology Normal ana Morbid. By C. A. Mercier, M.B. Pp. xvi+578. (London: Swan Sonnenschein and Co., Ltd., 1901.) Price 15*s*.

MR. MERCIER'S "morbid" psychology is, as one would naturally expect, the best part of his book, and almost as good is the general discussion of the questions raised by pleasure-pain and by emotion. The author dissents from Prof. James's "back-wave" theory of emotion on much the same grounds which have led to its rejection by Stout and other contemporary psychologists, and, like Stout, rightly insists that the dependence of emotion upon an object beneficial or injurious to the organism must be the starting-point of any theory of its nature. An interesting feature of the discussion of pleasure-pain is the writer's belief that there are no reproduced ideas of pleasure and pain. The present reviewer is inclined to agree with him, but the question is a difficult one. In his general theorising Mr. Mercier is far too ready to accept associationist views which are virtually dead in the scientific psychology of to-day. This is specially true of his account of perception, which is identical with Spencer's, but quite at variance with the doctrine (which pathological cases as well as the study of animals seem to demand) that "ideas" are subsequent to precepts.

The weakest part of the book is the long section on logic, which is also, strictly speaking, irrelevant in a treatise on psychology. The axiom formulated on p. 86 would justify the inference, "Solomon is the son of David, and David the son of Jesse, therefore Solomon is the son of Jesse." The furious attack upon the mathematical doctrine of probability also rests largely upon the pure misconception that the statement of chances is put forward by mathematicians as a measure of the actual strength of our belief. A. E. T.

A Record of the Progress of the Zoological Society of London during the Nineteenth Century. Edited by the Secretary. Pp. 248. (London: Clowes and Sons, Ltd., 1901.)

UNDER the auspices of a committee consisting of Mr. Sclater, Dr. Smith Woodward, Prof. Howes and Mr. Beddard, Mr. Scherren has prepared an excellent account of the principal doings of the Zoological Society since its foundation in 1826. The statements made are partly financial and partly relate to the number of the public who have availed themselves of the opportunity of entering the gardens, as well as to the papers read before the Society and to the lectures delivered in the gardens. It is curious to note the gradual growth of the popularity of the Zoological Gardens as a place of resort, a growth which is not altogether *pari passu* with the increasing population of the country. Thus from 1872 to the present day the number of visitors has always exceeded 600,000, and in two notable years, viz. 1876, when His Majesty the King, then Prince of Wales, deposited the animals brought back by him from India, and again in 1882, the year of the "Jumbo-mania," exceeded the usual maximum by a hundred or two hundred thousand. From 1864 to 1871 the numbers were 500,000 and upward, while in earlier years the average number was not more than 300,000 to 400,000, with the exception of the phenomenal years 1851 and 1863, when the admissions rose to more than 600,000. The earliest year in which these numbers are recorded is 1829, when only 98,605 persons visited the gardens. The numbers then rose and again fell during the 'forties. During these seventy-four years there have been eight presidents, seven secretaries and three vice-secretaries. The late Earl of Derby and the late Sir William Flower held their office of president for the longest period, viz. twenty years, and next in order of tenure come the Prince Consort and the Marquess of Tweeddale, who occupied the chair for ten years each. This volume contains also a list of the present Fellows of the Society and the charter and bye-laws.

Leitfaden der Landschafts-Photographie. By Fritz Loescher. Pp. v + 162. (Berlin: Gustav Schmidt, 1901.) Price Mk. 4·50.

WITH so many books in the English language on the subject of landscape photography, the amateur or professional may not think it worth while to read any new German work on the subject. This, however, should not be the case, for from such a volume as the one under notice it is possible, not only to obtain useful hints familiar on the Continent and unknown here, but at the same time to acquire facility in reading a foreign language.

The reader will certainly not be disappointed when he spends a few hours in becoming acquainted with what Herr Loescher has to say in these 162 pages, for although the author goes, for the main part, over familiar ground, yet here and there a subject or object is seen from a new point of view.

The book is logically divided into three parts, namely, before the exposure, the exposure and after the exposure. The first deals with the apparatus generally employed in tripod and hand-camera photography, touching on the use and determination of the speed of shutters, perspective as produced by the objective, various kinds of and uses for photographic plates, and useful hints as regards packing, &c., for those who make long tours with cameras.

The second portion is restricted to the choice of the subject and the best way to photograph it, the author here giving some valuable suggestions on the consideration of distance, foreground, trees, sky, illumination and minor accessories to the picture. In the third and last portion of the book the treatment and after treatment of the exposed plate are described, the latter including all such manipulations as intensifying, retouching, copying, mounting, framing, enlarging and lantern-slide making.

Accompanying the text are twenty-four autotype reproductions from the author's own negatives.

Inductive Sociology. By F. H. Giddings, Ph.D., LL.D., Professor in Columbia University, New York. Pp. xviii+302. (London: Macmillan and Co., Ltd., 1901.) Price 8*s*. 6*d*. net.

THE object of this book, in the words of the author, is "to present a scheme of inductive method, a somewhat detailed analysis and classification of social facts, and a tentative formulation of the more obvious laws of social activity." It is not in any way a mere discussion of the possibilities of census taking, but an attempt to formulate a general scheme for the statistical, or quasi-statistical, description of a nation or "society," using materials from every available source. Thus the description covers the features of the area inhabited, the nature and sources of the food supply, the density, multiplication, migration, &c., of the population, and its racial composition; the political activity, cooperation for social ends, and general organisation of the society; its social security and administration of justice; wealth and its distribution; education; vitality and morality. The work is prefaced by four introductory chapters on the study of sociology and the inductive methods to be used.

It is gratifying to find a writer on sociology acquainted with modern mathematical methods of statistics, and one who clearly recognises the value of such methods, but the definitions given in Chapter iii. of the introduction require some rewording. The word "number" on p. 21 is apparently used in the sense of "magnitude of the variable" instead of in the more natural sense of "frequency," but even in this sense it would not be correct to define the median as "the number midway between the lowest and highest"; it is correctly defined by the statement that magnitudes greater and less than the median occur with equal frequency, so that the median will not in general coincide with the middle of the observed range. Again, it is hardly correct to speak of a measure of variation as the "*mode* of the deviation"; mode is used in the sense of "most frequent value," and the most frequent deviations in the case of symmetrical distributions will be those approximating to zero. The term "standard deviation" was defined by Prof. Pearson, its introducer, in the sense of root-mean-square deviation, and it is apt to lead to misunderstanding if used in a vague sense, as in the text. The section on the "law of sympathy," pp. 108–110, would also be the better for, at least, some additional explanation; it is from its curtness almost incomprehensible as it stands, and some of the symbols used appear to be only defined in the appendix.

The book is suggestive of many possible lines of research by means of indirect statistical index-numbers, but we cannot help feeling that the author has tried to cover ground too wide for a single volume. The work as it stands is so abstract that it is almost impossible to estimate the practical value of the author's ideas, and such abstractness alienates the sympathy of the statistician. A much more liberal discussion of examples in the text would be both valuable and refreshing.

G. U. Y.

Optical Lanterns and Accessories. Edited by Paul N. Hasluck. Pp. 160. (London: Cassell and Co., Ltd., 1901.)

THIS handbook forms one of a series of practical manuals, and it brings together the more important and useful information in relation to the construction and management of optical lanterns. For the main part the editor has utilised material which has been published from time to time in the weekly journal *Work*, and has coordinated it in such a form that it will be found very serviceable to those who have much to do with lanterns. There are also chapters on the making of ordinary photographic, coloured and mechanical lantern slides, and some useful hints regarding the management of kinematographs. The book is well illustrated and should be found very handy.

Plane Geometrical Drawing, including numerous Exercises and Army Examination Papers, with Solutions. By R. C. Fawdry, M.A. Pp. xi+185. (London: E. and F. N. Spon, Ltd., 1901.) Price 6*s*. net.

THIS is a work of quite an elementary character, and very well suited to candidates for admission to Woolwich and Sandhurst. A good feature of the book is that it either gives a proof for each construction or refers to the particular proposition of Euclid on which the construction is founded. In addition to constructions relating to right lines, triangles, polygons and circles, there is a short chapter on the ellipse, which, in a second edition, might very well include a treatment of the parabola, inasmuch as the parabola is at once one of the simplest and the most useful of curves in the applications of mathematics. There are two good chapters on the use and construction of scales, and the book concludes with several specimens of papers set in the subject at the Woolwich and Sandhurst examinations, together with the solutions of the questions.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

The "Chestnuts" of the Horse.

THESE structures are well known and have been variously interpreted. But I believe that a suggestion as to their nature which I shall now put forward has not yet been made. Some months since I called attention in this Journal (vol. lxii. p. 523) to the general prevalence among mammals that use their fore limbs as grasping or climbing organs—in fact, in all other ways excepting as mere organs of progression—of a tuft of long hairs upon the wrist. I have since that time examined a large number of mammals, and find these vibrissæ in a considerable number of genera belonging to the orders Marsupialia, Rodentia, Carnivora, Lemuroidea (in which latter group the vibrissæ in question were first noted by Mr. Bland Sutton). They are absent from the Ungulata with the exception of hyrax, an admittedly ancient type of ungulate. Usually, but not always, a stout branch of the radial nerve of short extent ends in this patch of integument which bears the vibrissæ. The vibrissæ are quite similar to those found upon the head of the same mammals, for example the "whiskers" of the cat. The general occurrence of this carpal tactile (?) organ makes it, at least on *a priori* grounds, reasonable to suppose that traces might be met with in the ungulates, other than hyrax, where it unquestionably exists. There might not at first sight appear to be much in common between the callous pad, such as is the "chestnut" of the horses and asses, and this tuft of vibrissæ; but the conditions which I found to obtain in an armadillo (*Dasypus villosus*) suggested the comparison. In that animal the carpal tuft of vibrissæ is present; but instead of being a closely compacted tuft of about six hairs, as is usually the case, the hairs in the armadillo are not much larger than those of the skin generally, and are spread over a patch of integument of about half an inch in length and are more numerous. The patch of skin which bears them is thickened. If this were to proceed further the more strongly cornified epidermis would cease to bear vibrissæ, which would be, so to speak, driven into a corner beyond the specially thickened tract of skin. This stage, moreover, is not hypothetical; for in *Lemur catta* precisely this state of affairs exists, *i.e.*, a callous tract of skin close to which is a tuft of vibrissæ. If the latter were lost we should have the "chestnut" of the horse. The chestnuts on the fore feet, be it observed, occupy the right position, a little above the wrist.

FRANK E. BEDDARD.

Frost Patterns.

AS I was responsible for opening the discussion in these columns in 1892 and as I am able to confirm Dr. Catherine Raisin's observation as to the recent recurrence of the phenomenon on December 15, I am glad of the present opportunity of sending a few lines on the same subject in order to rectify an omission. In 1873 Prof. Joseph Henry, of the Smithsonian Institution, Washington, forwarded to Prof. Tyndall on behalf of Prof. Lockett, of the Louisiana State University, a beautiful photograph of "plumes produced by the crystallisation of water," the said pattern having been formed in the coloured sediment in the bottom of a basin in which the water had frozen during the night. This photograph is reproduced as a plate in Tyndall's "Lectures on Light" (I have only the second edition, 1875). It escaped my notice during the correspondence in 1892 or I should certainly have called attention to it.

R. MELDOLA.

Roads and National Welfare.

IN NATURE of December 19, 1901 (p. 149) is given a criticism of a work, in which some essential points in the making and maintenance of roads are strongly insisted on. At p. 156 of the same number there appears an excellent commentary on Mr. Balfour's speech to the students of the Goldsmiths' Institute at New Cross on December 12. With your comments I am in thorough sympathy, and would beg leave to point out that the two subjects are far more closely connected than might at first appear. Excellence and superiority

in manufactures and commerce depends on very many elements, as you know, one of the most important of which is the "item" "carriage or transport." British superiority in many manufactures and markets has depended, and will henceforth largely depend, on that one item principally (take the case of iron ores), and to maintain superiority it must receive in the immediate future more careful attention and scientific treatment. Roads in their different forms enter largely as factors into the general question of "transport," and if trade superiority is to be maintained they must be looked after and treated, all over these countries, in a more scientific and skilled manner than that now prevalent in the United Kingdom. For that end there must be attained, as soon as possible, uniformity of make, treatment and control, and the highest efficiency as regards care and maintenance, and to ensure these results they should be placed under the charge of a body of trained engineers, such as those of the "ponts et chaussées" of France. The question to a certain extent resembles that of the currency of the realm, and as there is a perfectly uniform coinage for every part of it, so should the make and use of the roads be of one standard all over the kingdom, in the best interests of all who travel or convey goods. The Board of Trade controls the railways, why not a Board or Department for the roads? and thus obviate the many absurd and scandalous practices which exist and are allowed to prevail, to the great discomfort and loss of the community. Allow me to give my experience of what is taking place in the township of Pembroke (Dublin). The road "metal" mostly in use is simply the coarser riddlings from the drift gravel so abundantly and cheaply worked in the neighbourhood of the Town Hall. The stones, perfectly rounded, incapable of taking bond and largely composed of entirely rotten elements, are loosely thrown here and there, where prominent holes appear. Mr. Beete Jukes, the former head of the Geological Survey of Ireland, remarked when he saw the material used, that boiled potatoes might as well be employed, and the rapid wear fully bears out the correctness of this judgment, and hence a large staff of scavengers and carts, discomfort for all classes of road-users, and steady increase of rates. In a southern county I have seen the road surface worn into the form of the section of an inverted arch, and was informed by a competent authority that the county surveyor, a Whitworth scholar, secured the place as the result of a Civil Service examination, the pay being about 800*l.* per annum, and thus secured, proceeded to develop a private practice as civil engineer, leaving the roads to attend to themselves. Many other examples of this nature might be given. As to the importance of good roads from a military point of view, it should be unnecessary for me to refer to it. I see from time to time the Dublin garrison companies and battalions out on marching exercise and notice the draggled appearance in which the men come home when the weather is in any way moist or rainy, and reasonably associate this condition with the bad state of the roads about Dublin. The Romans certainly knew better on this branch of military engineering, and might still be copied. As for agriculture, the Americans have gone thoroughly and systematically into the question, and are taking effective measures to put their road systems into a proper working state, and to have them kept up to it. I trust, Sir, that you will excuse these rather extended observations and that you will see your way to urging the pressing importance of a uniform and general system of road making and maintenance for the kingdom on the grounds of high State utility, commercial importance and agricultural necessity.

J. P. O'REILLY.

Dublin, December 28, 1901.

Preoccupied Names in Zoology.

THIS afternoon I spent a lttle more than half an hour over the "Zoological Record" for 1899, looking for preoccupied generic names proposed in that year. The result was as follows:—

Baris, Loos, for a plathelminth in the alimentary canal of Chelonia is untenable because of Baris, Germ., a genus of beetles.

Astia, Loos, for a worm in gut of Tetrodon; *nec* Astia, Koch, an arachnid.

Brotella, Roverto, new name for Acrostoma, which was preoccupied; *nec* Brotella, Kaup, in fishes.

Cumopsis, Roverto, new name for Cuma, Humph., preoccupied; *nec* Cumopsis, Sars, Crustacea.

Eichwaldia, Smitt, new subgenus of Gobius; *nec* Eichwaldia, Bill., Mollusca.

Goniopsis, Melichar, new genus of Fulgoridæ; *nec* Goniopsis, Haan, Crustacea.

Halticella, Jacoby, new genus of beetles; *nec* Halticella, Spinola, Hymenoptera.

Xenus, Péringuey, new genus of beetles; *nec* Xenus, Kaup, in birds.

I left off with the feeling that by taking time such instances could be multiplied almost indefinitely!

This is a condition of affairs which is becoming intolerable. None of the authors of the above names had even taken the trouble to consult the "Nomenclator Zoologicus." Such names become current for a number of years, until someone happens to discover that they have been used before. The result is an inconvenient though necessary change and a useless synonym. Sometimes authors will not even correct these errors of nomenclature when their attention is directed to them, and if they do propose a substitute there is no telling whether it will be valid.

Would it be practicable for some representative body, such, for instance, as the staff of contributors to the "Zoological Record," to examine every new generic name proposed and issue from time to time a list of substitutes for names found untenable? Or, if it were preferred, the author in each case could be asked to propose a substitute, and then all the substituted names could be given in an appendix to the "Zoological Record." Whatever is done, it seems necessary that these errors should be promptly corrected, and equally plain that this cannot be left to the unaided intelligence of authors.

T. D. A. COCKERELL.

East Las Vegas, New Mexico, U.S.A., December 16, 1901.

A Luminous Centipede.

MR. R. I. POCOCK, to whom I sent the subjoined extract from notes made by me on June 5, 1897, has suggested that the observation would be of interest to readers of NATURE. He remarks: "The two new facts you have observed—namely, the defensive purpose of the substance and its irritating properties—are, I think, sufficiently important to put upon record." The notes are as follows:—

"Under the entrance gate, in the gravel, I saw a light of a brilliant greenish-bluish tint; it moved forward, leaving behind a trail of light which, gradually separating, became a scattered mass of brilliant points. The leading light had the form of a living, curving thread. A lighted match soon showed what the scattered points of light in its trail were, a dozen or so of red ants pursuing the Geophilus; one was clinging to it, each ant shone like a spark in the gravel, the centipede had discharged its fluid over them. I picked up the centipede and dropped it into a tumbler, where it splashed out a mass of light. Hurriedly placing my hand over the tumbler to prevent the insect from escaping, I felt suddenly a strange prickly sensation such as is caused by a slight contact with electricity, so that I hastily removed my hand, calling to a friend who, placing her hand over the tumbler, felt the same thing.

"I lit another match and watched the Geophilus writhe the light out of its body in blue-green flashes. It soon ceased to shine, having probably exhausted all the luminosity on its enemies.

"Defence seems certainly to be one of the uses of this secretion, attributed by some authors merely to purposes of attraction.

ROSE HAIG THOMAS.

"The White House, Basildon, Reading."

The New Planetoid.

THE note on Prof. Pickering's announcement of the discovery of a new planetoid moving in a very elliptic orbit, in the Astronomical Column of your issue of December 19, 1901, was read by me with much interest.

I should, however, like to point out that the orbit of the new planetoid is not the most elliptic yet known, that place being held, I believe, by Æthra (132), for which ϕ amounts to 22° 32′ (Watson's orbit), while for the new planetoid ϕ is 22° 8′.

Andromache (175) might also be included among those for which ϕ exceeds 20°, in addition to the two named in the note, Eva and Istria, its excentricity being 0·348 (Watson).

S. B. GAYTHORPE.

Prospect Road, Barrow-in-Furness.

SCIENTIFIC BALLOONING.

THE exploration of the upper air has become increasingly attractive as a branch of meteorological inquiry, and the soundings of the ocean of air, to use Mr. Rotch's expression, may be held to include observations at high-level stations, records obtained from instruments carried by kites or unmanned balloons, as well as observations made by travellers in free balloons. Of these the last mentioned offer most attractions for the adventurous, and they form an essential part of scientific inquiry, because eye observations can be taken of clouds and other atmospheric phenomena from a point of view not otherwise attainable, and experiments that throw light upon the working of various instruments can be carried out under conditions which cannot be exactly imitated on the earth's surface. For meteorological purposes the usefulness of a free balloon is, however, to a certain extent limited by the fact that the balloon is an aërostat; it is carried with the stratum of air supporting it and the only motion relative to the atmosphere is a vertical one. Wind as understood at the surface is therefore beyond the scope of observation of the balloonist, and all meteorological observations that are dependent upon the motion of air are not primarily suitable for the car of a balloon, where the air is calm and still even in a rapidly moving atmosphere.

The traveller can in clear weather estimate the rate at which he is borne along by noting the places over which he passes, and he can obtain permanent records of his voyages by photographs taken from his car, which suggest a curious reminiscence of old-fashioned maps. A photographic camera is indeed the first and most natural item in the equipment of a balloonist, whether the aim of his voyage be scientific inquiry or merely adventure. One of the most novel and successful departments of the Paris exhibition of 1900 was the aëronautical section, which gave full opportunity for the display of the powers of aërial navigation. During the exhibition fourteen competitions were held, in which a hundred and fifty-six ascents were made. The competitions were of four kinds; for altitude, for duration of voyage, for distance and for descent at a specified spot. The competitors were exclusively French; the greatest height reached was 8417 metres, the longest voyage in time lasted 35·45 hours and covered also the longest distance, namely, 1925 kilometres; the nearest approach to a given point was within 400 metres, after a voyage of 32 kilometres. Of the 156 voyages, 137 were completed within France, ten extended to Germany, three to Belgium and three to Holland, while three were not terminated until the Russian frontier was passed. It is satisfactory to note that all were conducted without accident either to aëronaut or spectator. Among the many interesting photographs obtained during these expeditions is one of the neighbourhood of the Panthéon, Paris, taken from a height of 500 metres and reproduced (Fig. 1) from an article by Commandant Renard in the *Bulletin* of the Société d'Encouragement pour l'Industrie Nationale. For the purpose of comparison, a photograph of Berlin from a height of 2000 metres, taken in 1893 on one of the voyages of the ill-fated balloon *Humboldt*, is also reproduced (Fig. 2). It shows the Belle Alliance Platz in the centre, but the scale is evidently very small. A slightly larger view (Fig. 3) of the central portion, taken on another occasion, is here reproduced from the frontispiece of Prof. Assmann's memoir, "Die Modernen Methoden zur Erforschung der Atmosphäre mittels des Luft-ballons und Drachen," which appeared in the March and April numbers of *Himmel und Erde* last year.

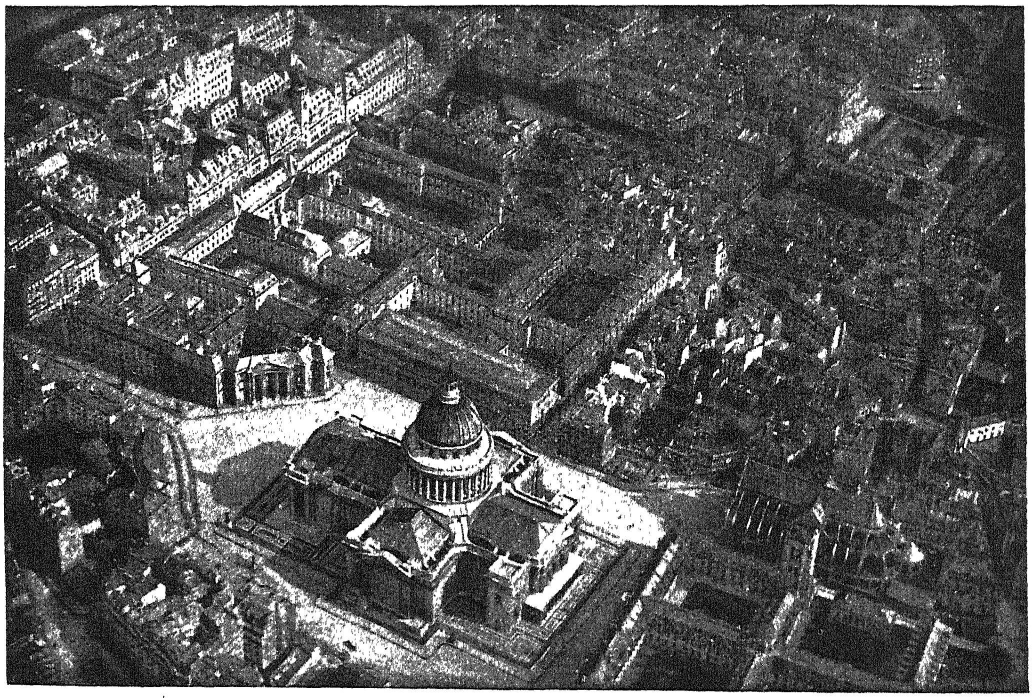


FIG. 1.—Neighbourhood of the Panthéon, Paris, photographed from an altitude of 500 metres.

Among the best known establishments for exploring the upper air are those of M. Teisserenc de Bort at Trappes for "ballon sondes" and kites and Mr. Lawrence Rotch for kites at Blue Hill, Massachusetts; but the general use of balloons for scientific purposes has been carried out most effectively at Berlin. By means of funds supplied

by the Emperor William, a very complete establishment for the exploration of the upper air has been installed there. The first balloon acquired was the *Humboldt*, which made its first voyage on March 1, 1893. It was fired by

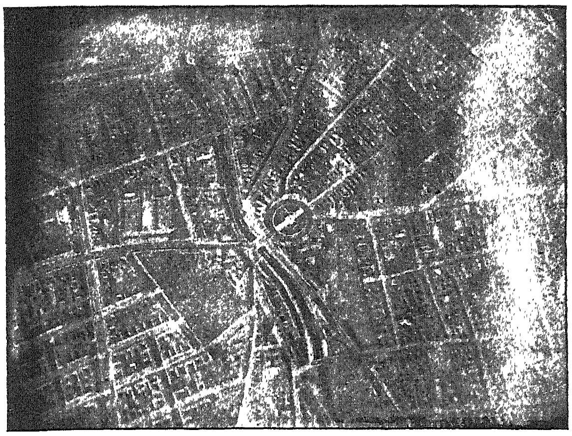


FIG. 2.—South-west Berlin (Belle Alliance Platz), photographed from an altitude of 2000 metres.

an electric spark and destroyed on landing after its sixth voyage. Through the Emperor's generosity it was replaced by the *Phönix*. Prof. Assmann, in the work already referred to, gives some particulars of the arrangements and results, but the subject is more fully dealt with in a work consisting of three handsome volumes published last autumn and entitled "Wissenschaftliche Luftfahrten ausgeführt vom Deutschen Verein zur Förderung der Luftschiffahrt in Berlin" (Braunschweig: F. Vieweg und Sohn). This contains the account of seventy-five voyages and a number of flights of unmanned balloons, together with the material collected in the course of the expeditions, maps of the regions traversed and a volume of results. The meteorological interest of these voyages is very great, but the work is too elaborate for brief summary. A single example may give some idea of the possibilities of investigation of this kind. On July 6, 1894, the *Phönix* started from Berlin at 6.32 p.m. and travelled north-west to Jutland in nineteen hours; the unmanned balloon *Cirrus* was started at the same time from the same place and was carried by an upper current to Bosnia.

The primary meteorological question to be determined by balloon ascents is the rate of variation of temperature with height. For some time after Glaisher's celebrated voyage of 1862, which concluded his balloon work, the matter was regarded as settled. The Berlin work has reopened it on the ground that the thermometers used by Glaisher were not sufficiently ventilated or screened from radiation. Glaisher was aware of the necessity for precautions, although he discarded special apparatus for ventilation, and his immense experience in the use of thermometers might enable him to obtain results, as, for example, with Daniell's hygrometer, where others of less skill and experience would fail. In the balloon investigations by Berson, Assmann's ventilation thermometer, with special mounting to avoid the car's interference, was used, and every precaution was taken to make the circumstances otherwise comparable with those under which Glaisher made his memorable ascent from the Crystal Palace. M. Berson carried these precautions even to the length of making an ascent from the Crystal Palace itself on September 15, 1898, while a simultaneous ascent was made at Berlin, to make sure that the observed differences were not due to climatic differences between the air over Germany and over England. The day was remarkably hot in England, the temperature being 10° C. above that of Berlin, but the zero isotherm was found within a few hundred metres of 6000 metres at each station. Further trial was made by reproducing Glaisher's arrangement from his description and comparing its readings with the Berlin arrangements. The results were only accepted as conclusive after careful consideration of all the measurements of temperature obtained from the numerous flights of manned and unmanned balloons. In the end Berson was satisfied that the difference of the observations was to be laid to the account of instrumental errors in Glaisher's observations.

The comparison of Glaisher's and Berson's results for the rate of fall of temperature with height, as given by Assmann, is as follows:—

Height in metres.	Rate of fall in Centigrade degrees per thousand metres.	
	Glaisher.	Berson.
0–1000	7·5	5·0
1000–2000	6·5	5·0
2000–3000	5·0	5·4
3000–4000	4·2	5·3
4000–5000	3·8	6·4
5000–6000	3·2	6·9
6000–7000	3·0	6·6
7000–8000	2·0	7·0
8000–9000	1·8	9·0

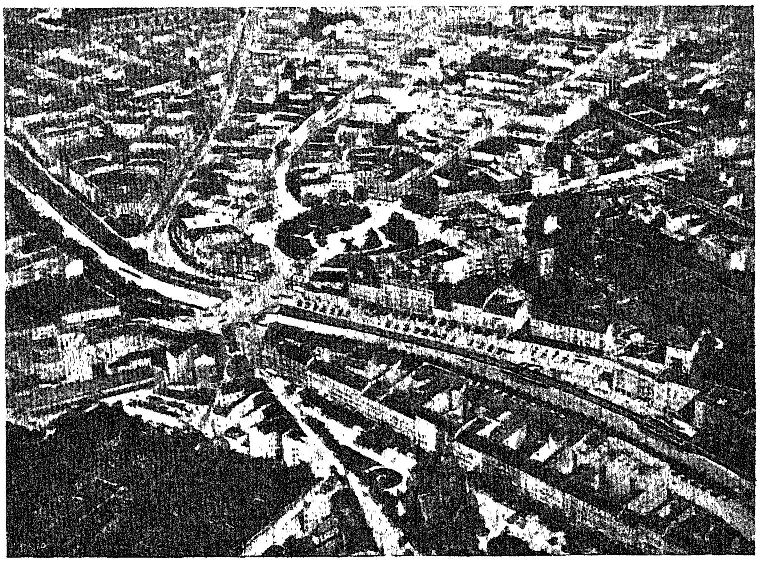


FIG. 3.—Neighbourhood of the Belle Alliance Platz, Berlin, photographed from a balloon.

It will be noticed that whereas Glaisher's observations lead to the conclusion that a constant temperature is indicated at no very great height, Berson's numbers show increasing rate of fall with height, so that the difference

in the results is one of fundamental importance. Berson's numbers clearly do not go to the end of the matter, for with a little play of the imagination in the region of extrapolation, his results bring absolute zero within sight at the very moderate height of some thirty miles, whereas $-68°$ C. is the lowest temperature recorded in the flight of the unmanned balloon *Cirrus* from Berlin, which is reported to have reached a height of 18,000 metres. This, by a curious coincidence, is identical with the lowest temperature recorded at the earth's surface. It was registered at Werchojansk, in Siberia, on January 15, 1885; a still lower temperature, $-70°$ C., is given in the *Meteorologische Zeitschrift* for June as registered by the apparatus of an unmanned balloon started from Vienna on January 10 of last year. Kite observations also afford information as to the rate of fall of temperature under varied meteorological conditions. But the height which they can attain does not give them a final voice in the determination of the question of the lowest limit of atmospheric temperature.

Another quantity for the determination of which balloon observations are specially appropriate is the constant of solar radiation, but the results are not yet final and the subject is too wide for this occasion.

It would be a matter for congratulation if Glaisher's exploration of the upper air could be continued by his own countrymen. Investigations have, indeed, been made recently by the Rev. J. M. Bacon, and, under the auspices of the Aëro Club, by the Hon. C. S. Rolls. But for the use of balloons on any considerable scale these islands are not very suitable. It will hardly yet be forgotten that some years ago an attempt to pursue scientific investigation in this manner resulted in the loss of a valuable life. Work with kites even is not without its dangers, but it is satisfactory to note that the Royal Meteorological Society has taken up this mode of investigating the upper atmosphere, and has not only moved the British Association to devote a sum of money for the purpose, but has secured the active interest of the president of the Society, Mr. W. H. Dines, in the undertaking. The British Isles occupy such an exceptional position with regard to the passage of weather changes from the Atlantic Ocean that the results of a properly directed inquiry of this character can scarcely fail to throw important light on many meteorological questions.

One of the results of the Congress of Meteorologists at Paris in 1900 was an international arrangement for the simultaneous exploration of the upper air in the various countries of Europe by means of unmanned balloons carrying self-recording instruments. An ascent was to be made on a fixed day in the first week of each month. Prof. Hergesell, of Strassburg, chairman of the Aëronautical Committee of the International Conference, undertook the collection and the working out of the results. The ascents have been regularly carried out and brief reports have appeared in the *Meteorologische Zeitschrift*. In this country Mr. P. Y. Alexander, of Bath, has carried out ascents of unmanned balloons on some of the appointed days, and has made provision for observations in manned balloons by Mr. Spencer. With the balloon observations are associated observations of clouds. We have no system of systematic measurement of cloud movements, but in connection with the balloon ascents the following observatories have furnished eye observations of the form and motion of clouds on the days of the ascents and the preceding and following days, viz. Greenwich, Kew, Oxford, Bidston, Stonyhurst, Rousden, Falmouth, Glasgow, Aberdeen and Valencia. The returns have been sent to the Meteorological Office to be forwarded to Prof. Hergesell. The details of the ascents of November 8, 1900 (the tenth of the whole series of international ascents) have already been published, and they show in a very effective manner the initial increase of temperature with height in the region of the anticyclone which covered the continental stations, Paris, Strassburg, Berlin, Vienna and St. Petersburg, at which ascents took place. Inversions of temperature are also very marked in the discussion of the Vienna observations for the ascent of January 10 by J. Valentin in the *Meteorologische Zeitschrift* for June.

For meteorological purposes balloons will be much more serviceable when the means for converting them from aërostats into airships are perfected. It is fifteen years since Commandant Renard, who with his brother has been so active in all that concerns military ballooning in France, published his lecture, "Sur la Navigation Aérienne," before the Société de Secours des Amis des Sciences, in which he lays down with true French clearness the dynamical conditions for the airship as distinguished from the aërostat. The publication is illustrated with a picture of an airship corresponding very closely with those of the airship of M. Santos Dumont that have attracted so much public attention within the last few months. At present airships are at best fair-weather vessels, and fair weather is a dull subject for meteorologists.

W. N. SHAW.

GUN-SIGHTS FOR LARGE AND SMALL ORDNANCE.

UP to quite recent times but little has been done by those interested in gunnery to improve in a really practical way the method of aiming either a rifle or gun. The usual method of aiming is much the same as that employed long ago in using the mediæval crossbow. The object aimed at, the fore-sight and the back-sight, are brought into line by the eye of the marksman, always with this defect, viz., that the eye is out of focus with respect to two of the points mentioned when focussed on the third. We know well that, if we fix our attention on a distant object, our eye will automatically focus itself on that distant object; and only an indistinct image of the foresight will be present. Again, should we focus the eye on the fore-sight, then the object aimed at will not be clearly seen. This is also true in an accentuated manner with respect to the back-sight, since it is nearer to the eye than the fore-sight. The operation of thus aiming, even in the best circumstances of light, is obviously unsatisfactory.

The gun-sight problem has been attacked by several leading experimentalists, and in the majority of cases some apparatus in which lenses are employed has been used. An early form of optical gun-sight consisted of a small telescope attached to the gun, the telescope being furnished with an eye-piece and cross-lines or webs, similar to those used in the surveyor's level or theodolite. This telescope is attached to the rifle by a joint at one end, the other end being raised or depressed to suit the range by means of a milled headed micrometer screw. The telescope-sight has been applied to field and other guns, and to it has been added an inclinometer, so that an angle inclination either above or below the horizontal line can be given to the gun.

Objections have been raised to the telescope-sight, and it has been urged that the field is limited, so that it is not easy to "pick up" the object to be hit, and that the object appears to be moving with a speed greater than its real one, also that when heavy charges of gunpowder are used, and the recoil is considerable, there is a risk of the eye of the marksman being injured by the cap of the eye-piece when it is driven back, and also that the adjustment of the telescope may be thrown out, by the concussion on firing the piece. With respect to the first objection, in the case of a man with short sight, the telescope-sight is of great use since it enables him to see the object as clearly as a man with normal vision. When the telescopic method is used for laying field guns, the

sight is placed in a geometric bracket for aiming and removed immediately before the gun is fired, as otherwise it would be injured by concussion.

The gun-sight invented by Sir Howard Grubb, F.R.S., is free from imperfections inherent in the old form of telescope-sights used on rifles. The new instrument is called by him the "Collimating-telescope Gun-sight," and a paper on the subject in the *Transactions* of the Royal Dublin Society (March 20, 1901) at once shows what considerations led up to the invention of the new form of gun-sight. In it the inventor pictures an ideal sighting arrangement thus:—He imagines a ring or cross to be carried on a very long, weightless and rigid rod forming a prolongation of the gun-barrel, so that the ring or cross would always be situated in the prolongation of the axis of the gun, and each shot, if the trajectory were quite flat, would pass through the ring. The inventor goes on to show that such an ideal rod might be realised by using a fine beam of light, which might be projected on to the object and indicate the direction of the axis of the gun. This end is in practice obtained by projecting a "virtual" image upon the object on which the gun is aimed. By means of the gun-sight now to be described a "virtual" image of a small bright cross or circle is projected on to the object aimed at. The earliest form

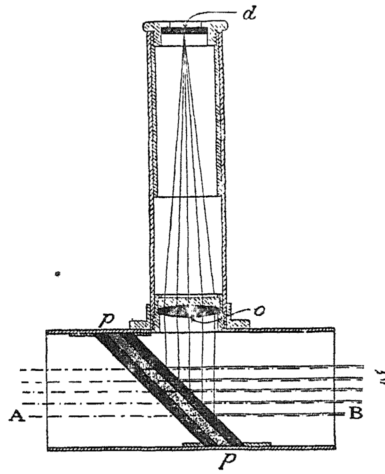


FIG. 1.

in which the gun-sight was made is shown in Fig. 1, in which the object aimed at is viewed through a piece of tube of square section AB, open at each end, a piece of parallel glass, *pp*, being fixed at an angle of 45° to the axis of the tube. In another tube at right angles to the former a diaphragm *d* is fixed, made of glass coated with an opaque substance, through which fine lines are scratched in the pattern of a cross or star or circle. *o* is an achromatic lens, and the distance between the cross and the lens equals the principal focus of the lens; so that rays of light passing through the cross, on reaching the lens, are by it made parallel, they are then reflected by the plates *pp* as parallel rays to the observer's eye, and the observer sees a "virtual" image of the cross coinciding with the object aimed at, and apparently at the same distance as the object. This optical device causes the cross to be seen sharply defined, with the same focussing of the eye required for viewing the distant object, and all straining of the eye, as is the case in the old system, vanishes; also there is no parallax, and therefore the eye need not be kept in one position. This "virtual" image of the cross, forms a fore-sight projected to a long distance in front of the rifle, as if it were carried upon an invisible, imponderable and inflexible prolongation of the barrel. This form of apparatus not being of convenient shape for practical use, the gun-sight eventually assumed the form shown in Fig. 2, in which *d* is the cross, which is reflected by the mirror C, on to a curved glass surface *rr*, coated with a very thin layer of galena, the ray is reflected as a parallel beam to the eye, and at the same time the

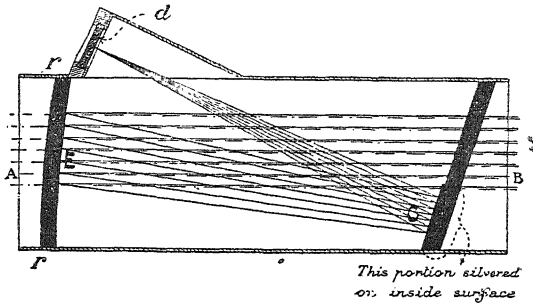


FIG. 2.

object is seen through the coated surface. The radius of curvature of *rr* equals twice the distances *d*C and CE. When the eye is placed anywhere near the axis of the gun-sight the bright cross is seen superposed on the object, and the usual effort required in the attempt to focus two objects not at the same distance is entirely avoided. The photograph (Fig. 3), taken by a camera

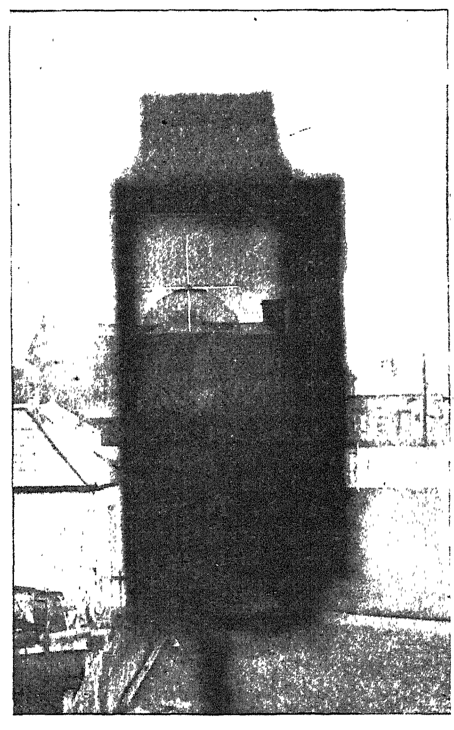


FIG. 3.

placed behind the gun-sight and focussed on the dome of a building, shows how perfectly the cross coincides with the object, both the object and cross being in perfect focus.

The gun-sight is mounted on a graduated metal arc attached to the rifle, by means of which it is adjusted for various ranges. The sight may be used either with or without a telescope or monocular, since the same focus

suits both the object and the image of the cross; also by cutting divided scales on the diaphragm glass, useful estimates may be made of both distance and windage.

In an experiment made on a gun-sight, kindly lent to the writer of this article by Sir Howard Grubb, good shooting was made on a white target when it was dusk, and an ordinary fore-sight could not be seen, by illuminating the cross, by a minute reflected side-light, entirely shielded from view from the locality of the target. This form of gun-sight could thus be used, in certain circumstances, long after the ordinary fore-sight had become invisible.

A very small diminution of light coming from the object is produced by the deposit of galena on the mirror, but it is so minute, that it practically causes no inconvenience to the marksman when aiming a rifle at a distant object.

NOTES.

PROF. ALBERT GAUDRY has been elected vice-president of the Paris Academy of Sciences for the year 1902.

THE Symons Gold Medal of the Royal Meteorological Society will be presented to Dr. A. Buchan, F.R.S., at the annual meeting of the Society to be held on Wednesday, January 15.

WE regret to see that Prof. Virchow met with an accident on Saturday evening while alighting from an electric tramway car in Berlin. The injuries are described as a wrench to the hip joint and various contusions on the legs, in consequence of which Prof. Virchow will for a long time be confined to his room.

THE Commissioners of the Northern Lighthouses have decided to adopt wireless telegraphy as a means of establishing communication between the mainland and certain of their lighthouses. The first installation will be at the Flannan Islands, which are situated about sixteen miles outside the west coast of Lewis. The installation, which will be made in conjunction with Lloyd's shipping agency, will be on the Marconi system.

THE New York *Electrical Review* for December 21, 1901, contains some interesting particulars concerning Mr. Marconi's recent success in transmitting signals across the Atlantic by wireless telegraphy. It appears that before leaving England Mr. Marconi made arrangements for having the letter "S" signalled repeatedly at frequent intervals for three hours daily from his transmitting station at Poldhu. The power of the transmitting arrangements in Cornwall had been increased considerably since Mr. Marconi had succeeded in bridging a distance of 200 miles. At St. John's there was only a temporary station, the aërial wire being suspended from a kite at an altitude of about 400 feet. The transmitting and receiving arrangements were carefully tuned, the receiver being of a new type recently developed. On December 14 a succession of "S's" was received with unmistakable distinctness, and a similar series was received on the next day, but this time not quite so distinctly. Mr. Marconi attributes the variability partly to fluctuations in the height of the kite, bad weather prevailing at the time, and partly to the fact that the receiver had to be extremely sensitive and required constant adjustment. The erection of a permanent station in America and the increase in the power of the transmitters should remedy these two defects. It is now almost exactly 150 years since Franklin's classical experiment with a kite, which now, therefore, figures for a second time as important in the history of electrical development.

THE following news from Baron Toll's Arctic Expedition was received by the chief of the Central Meteorological Observatory at St. Petersburg, in a telegram, dated Yakutsk, December 4/17:—"On September 11/24 caught by winter in Nerpichiya Bay, 75° 22′ N. and 137° 16′ (E. longitude). From November 1 have opened meteorological station, with hourly observations. All right, all well. Sending greetings to Central Observatory. *Zarya*, October 25 (November 7), 1901." It will be remembered that the expedition started last summer on board the steamer *Zarya* with the intention of wintering somewhere on the Arctic coast of Siberia, so as to begin in the spring the exploration of the New Siberia Islands.

THE Russian newspapers publish the following official telegram, dated Yakutsk, December 28:—"The expedition which was sent out by the Academy of Sciences, under the zoologist Hertz, to examine the mammoth remains discovered in the district of Kolymsk, has reached Sredne Kolymsk, after a very difficult journey, bringing the mammoth with it. The animal was a male and apparently middle-aged. Its skeleton and skin have been preserved nearly intact. The tail was short and covered with long hair. In the stomach, between the teeth and on the tongue, remains of undigested food were found. The different parts of the mammoth have been conveyed to St. Petersburg in a frozen condition."

THE eleventh Congress of Russian Naturalists and Physicians was opened at St. Petersburg on January 2 by the Grand Duke Alexander of Oldenburg. The number of people anxious to take part in the Congress was very large, more than 3250 members' tickets having been taken on the day of opening. The Minister of Public Instruction has given a sum of 500*l.* to defray the expenses of the Congress, and both the Municipality of St. Petersburg and the University have contributed large sums for the same purpose. At the first general meeting of the Congress, the president (Prof. Menschutkin) spoke about the foundation of a Russian Association for the Advancement of Science, which would hold regular congresses every year. This proposal was accepted by a congress held eleven years ago; but the Ministry of Public Instruction was hostile to the idea, and only now the new Minister, General Vannovsky, has agreed not to oppose it. At the same general meeting Prof. S. M. Lukianoff delivered an address on the limits of cytological research under normal and pathological conditions, in which he endeavoured to establish the limits of psycho-physiology; and Prof. N. A. Umoff delivered a brilliant address on a physico-mechanical model of living matter.

THREE pleasure cruises have been arranged by our contemporary the *Revue générale des Sciences* to take place this year. At Easter there will be an excursion to Greece and the Greek Isles, in charge of M. C. Homolle, director of the French School at Athens, and M. G. Fougères, of the University of Paris. At the end of September there will be a trip to Syria and Palestine, directed by M. C. Diehl, and in November an excursion will be made to Egypt, up to the second cataract, under the direction of a well-qualified Egyptologist.

ON Tuesday next, January 14, Prof. A. Macfadyen will deliver at the Royal Institution the first of a course of six lectures on "The Cell, its means of Offence and Defence, Immunity." On Thursday, January 16, Dr. A. S. Murray will begin a course of three lectures on "Recent Excavations at Delphi and in the Greek Islands." The Friday evening discourse on January 17 will be delivered by Lord Rayleigh, his subject being "Interference of Sound." On January 24 Mr. H. G. Wells will give a discourse on "The Discovery of the Future," and on January 31 Prof. A. Crum Brown one on the "Ions of Electrolysis."

THE Decimal Association has sent us a list of 172 members of Parliament who have notified their approval of the compulsory adoption of the metric system of weights and measures into Great

Britain, and have promised to give their support to any measure brought forward with this end in view. The Association points out that, in the interests of our foreign trade, it is most desirable that we should at once carry this reform into effect, as the constantly reiterated statements of British consuls prove that much trade is lost because our weights and measures are not understood in countries where the metric system is in force. In Australia, Canada and Cape Colony the change would be welcomed; and seeing how easily so serious an impediment to commerce can be removed, it is hoped that the Government will give more attention to the subject in the coming session of Parliament than it has so far done.

IT is announced that a large sum of money—about 200,000*l*.—has been placed at the disposal of His Majesty the King for charitable or utilitarian purposes by Sir Ernest Cassel. This money, by the King's direction, is to be devoted to the erection of a sanatorium for tuberculous patients in England. For the carrying out of this purpose His Majesty has appointed an advisory committee consisting of Sir William Broadbent, Sir Richard Douglas Powell, Sir Francis Laking, Sir Felix Semon, Sir Hermann Weber and Dr. C. Theodore Williams, with Dr. Horton-Smith and Dr. John Broadbent as honorary secretaries. The institution is to accommodate 100 patients, and will be fully equipped with all requirements for scientific research. In fact, it is intended to construct the sanatorium on the best lines which past experience and original thought can suggest, and in order to obtain the most valuable opinions a sum of 800*l*. will be awarded in prizes for the best essays and plans upon the subject. Medical men of all nationalities may compete. The papers may either be the work of a medical man or the joint production of a medical man and an architect. All essays and plans must be sent, postage paid, on or before April 15, 1902, to one of the secretaries of the committee:—Dr. P. Horton-Smith, 15, Upper Brook Street, London, W.; or Dr. John Broadbent, 35, Seymour Street, London, W. Three money prizes, of 500*l*., 200*l*. and 100*l*. respectively, will be awarded in order of merit on the recommendation of the advisory committee for the three best essays, provided they come up to the requisite standard of excellence.

AN astronomical observatory has been erected and equipped by the Bengal Government at the Presidency College, Calcutta, and was opened a few days ago. The idea of providing means for the instruction of Indian youths in practical astronomy was conceived about five years ago, when the Maharaja of Tipperah presented to the Presidency College an equatorial telescope by Grubb, 4½-inch aperture. On Dr. J. C. Bose's representation, the Government of Bengal agreed to provide a building suitable for observations. But it was not until after the eclipse of January, 1898, when the professional and amateur astronomers who visited India caused active interest to be taken in building the observatory. From an article in the *Pioneer Mail* we learn that the chief instrument of the observatory is a 7-inch equatorial by Sir Howard Grubb, with an electrically controlled driving clock and with electric lights for all the graduated circles. The telescope will generally be used for eye observations, but the object-glass may be adapted to photography, and the mounting of the telescope is of a strength that will admit of its being used for spectroscopic examination of the sun or the brighter stars. The equipment will allow a considerable number of students to become familiar with the elements of astronomy in its most practical form. It is hoped that the Presidency College Observatory will yet be equipped with more instruments through private liberality.

THE Geological Survey of the Colony of the Cape of Good Hope has recently been working in Pondoland, and has secured a very fine collection of fossils from the Cretaceous rocks which occur along the coast near Natal. The most interesting find of all was one of a pair of lower jaws belonging to a large reptile allied to Mosasaurus. The large trenchant teeth are set, each in a cylindrical socket and arranged in such a way that there is a series of teeth firmly anchylosed to the socket and other successional teeth that are loose and have fallen into the hollow of the fixed teeth. Many detached bones were also found, but the whole deposit is littoral, and very little can be made out of these, as they have been much rolled about on a shingle beach before becoming imbedded. With the Mosasaurus bones there are numbers of flat plates belonging to the bony carapace of a turtle such as Protosphargis as well as such characteristic chelonian bones as the Y-shaped one composed of the scapula and procoracoid. A large number of sharks' teeth occur between the pebbles belonging to the genera Corax, Lamna, Otodus, Enchodus, Odontaspis, and a single Elasmobranch vertebra was found. Between sixty and seventy genera of Mollusca were obtained, including many finely preserved examples, some of which are new to science and a great many new to South Africa. Echinoderms and Polyzoa also occur, and eight species of Foraminifera, belonging to the genera Vaginulina, Nodosaria, Virgulina, Discorbina, Truncatulina, Textularia. The collection is now in the South African Museum, Cape Town, where the greater part is exhibited.

ALMOST nothing is known of the amount of rain on the mountains in Arctic regions. Mr. Hamberg has placed large permanent pluviometers on some high mountains in Swedish Lapland and has observed that much more snow and rain fall there than in adjacent low ground.

IN the *Popular Science Monthly* for December, 1901, Mr. H. Helm Clayton, of the Blue Hill Meteorological Observatory, discusses the influence of rainfall on commerce and politics. He gives a table of the annual departure from the normal rainfall in the Ohio and Mississippi valleys for a large number of years, showing, not only that every severe financial panic has been closely associated with persistent deficiency of rainfall, but that (with one exception) no period of protracted drought has occurred without a financial panic.

The Geographical Journal for November last contains a paper by Mr. H. N. Dickson on the mean temperature of the atmosphere and the causes of glacial periods. The conclusions of the author tend to show that considerably smaller changes of temperature and of the distribution and amount of precipitation, caused by the assumption of a lowering of mean temperature taking place by cooling in the polar regions, than has generally been supposed, enable us to account for the nature and distribution of glacial phenomena, as they are at present known to us.

THE only countries which took part in the international balloon ascents during September, October and November were Austria, France, Germany and Russia. Some of the greatest altitudes were attained from M. Teisserenc de Bort's observatory at Trappes, near Paris:—On September 5 (night ascent), 14,178 m., temperature $-55^\circ{\cdot}2$ C., on ground $5^\circ{\cdot}6$; on October 3 (night ascent), 14,500 m., temperature -58°, on ground $8^\circ{\cdot}1$; (day ascent) 13,150 m., temperature -53°, on ground 11°; November 7 (night ascent), 13,200 m., -62°, on ground $2^\circ{\cdot}4$. From Berlin, on this day, an altitude of 12,010 m. was attained, temperature $-58^\circ{\cdot}4$, ground $6^\circ{\cdot}5$. A manned balloon which left Berlin, height 1100 m., temperature $+1^\circ$, experienced a wind velocity of 80 kilometres (50 miles) an hour.

IN our notes columns we recently directed attention (p. 110) to a paper by Prof. Lebedew in which he described an experimental investigation of the pressure of light radiation. We have now received a paper on the same subject, by Messrs.

E. F. Nichols and G. F. Hull, which was read at a joint meeting of the American Physical Society and the American Association for the Advancement of Science on August 29, 1901, and is published in the *Physical Review* for November last. The experimental methods adopted by Messrs. Nichols and Hull are similar to those employed by Lebedew, the chief difference being that whereas the former used a bolometer to measure the incident energy the latter employed a calorimeter, but the investigation is not as yet of so complete a nature. The observations already completed are, according to the authors, sufficient to prove experimentally the existence of a pressure of the nature and order of magnitude of radiation pressure. The results agree to within about 30 per cent. with the theoretical value: a certain amount of inexactness is introduced as the authors did not experimentally determine the reflecting power of the vanes employed. Lebedew in his investigation claims to have obtained results agreeing to within 10 per cent. with the calculated values of the Maxwell-Bartoli pressure.

IN view of the trials now being made by one of the London water companies with ozonised air as an agent for water purification, the following details of the experimental plant erected by Siemens and Halske at Martinikenfelde, near Berlin, are of interest. This plant was erected in 1898, and is adapted for treating 240 cubic metres water per twenty-four hours. The ozonisers are of the Siemens and Halske plate and tube type, and yield 20-25 grams ozone per E.H.P. hour, with an E.M.F. of 12,000 volts. The air passing from the ozonisers under these conditions contains $2\frac{1}{2}$–3 grams ozone per cubic metre. An air-pump is used to force the air through the drying chamber into the ozonisers, and it passes thence into the sterilising tower. This tower is a simple square structure packed with flints, and as the ozonised air passes upwards it comes into contact with a descending stream of water. The remainder of the plant at Martinikenfelde consists of a water-pump, a sand filter for preliminary filtration of the water with which the sterilising tower is fed, and various storage tanks for the filtered and unfiltered water. Tests made with water from the River Spree show that the numbers of bacteriological organisms were reduced from 600,000 to 10 per cubic centimetre. The permanganate absorption figure was reduced 18 per cent., and the aëration of the water was increased from 10 per cent. to 12 per cent. The consumption of ozone amounted to two grams per cubic metre. The cost of treatment for an installation treating 120-150 cubic metres per hour was estimated to be 1·726 pfg. per cubic metre, and the total cost, when interest and depreciation charges on the distributing system are included, 5·031 pfg. per cubic metre (equal to 1*s.* 5*d.* per 1000 cubic feet). The capital outlay upon an installation capable of treating 150 cubic metres per hour was estimated to be 6750*l.*, of which total 3750*l.* represented the expenditure upon the ozonisers and sterilising tower. Further details will be found in an article by Dr. Erlwein in the *Zeitschrift für Electrochemie*, November 14, 1901.

MR. SEALE, in *Occasional Papers* (vol. i. No. 4) of the Bernice Pauahi Bishop Museum, Honolulu, describes and figures several new Hawaiian marine fishes.

IN the *Comptes rendus* of the Swiss Society of Natural Science for 1900 Dr. Fatio adds two vertebrates—the lesser shrew (*Sorex pygmaeus*) and the Grecian frog (*Rana graeca*)—to the fauna of Switzerland.

IN an article published in the *Revue Scientifique* (*Revue Rose*) of December 28, 1901, M. Hugo de Vriês discusses the mutations of species and the periods required for such mutations. He mentions that since certain plants have apparently remained unaltered since the date of the building of the pyramids (approximately 4000 years), this period may be taken as a minimum unit in estimating the time required for specific modification.

To the eighty-third volume of the *Verhandlungen* of the Swiss Naturalists' Society Prof. C. Keller communicates a very interesting dissertation on a peculiar breed of domesticated sheep with goat-like horns formerly kept by the natives of the Bünden Oberland, Switzerland, and hence locally known as the Bündnersch. The breed is known to be of great antiquity, but now appears to be almost exterminated owing to crossing with other strains. In 1862 the late Prof. L. Rütimeyer called attention to the peculiarity of this breed, and indicated its near affinity with the so-called peat-sheep (*Torfschaf*) of the Swiss lake-dwellings, of which it appears to be the direct descendant. The author expresses the hope that efforts may be made to save the breed from extinction.

WE are glad to have the pleasure of congratulating the editor of the *Zoological Record* on the completion of the volume for 1900. Year by year his task grows more onerous, the volume before us exceeding its predecessor by 180 pages. Very noticeable is the length of the list of new generic and subgeneric names, which contains no less than 2102 entries, the maximum having been previously 1707, in 1895. The increase in the bulk of the volume is largely due to the insect record, which comprises 354 pages against 276 in 1899. The yearly growth in the size of the volume is, of course, largely to be attributed to the practice of naming local races of animals, which has come so largely into vogue of late. The various recorders appear to have done their work with great care and thoroughness, although we notice in the mammal part that one paper (No. 200) is credited to a writer other than its author. Uniformity in regard to the "introduction" to the different "records" is still a desideratum, this important element being altogether omitted in some instances, while in one case it has been allowed to reach an altogether disproportionate length. It is a decided improvement in the "get-up" that in this year's issue the edges have been cut. We are glad to hear that there is a good prospect of the promised "index volume" of generic names making its appearance early in the year.

NONE have laboured more earnestly on the land and freshwater Mollusca of Pleistocene and recent times in Britain than Messrs. A. S. Kennard and B. B. Woodward. Their latest work, "The Post-Pliocene Non-Marine Mollusca of the South of England," has just been published by the Geologists' Association (*Proc.* vol. xvii. November 1901). In this the lists from various localities have been carefully checked and revised whenever possible from an examination of the actual specimens recorded. Doubtful records are omitted from the general list, in which are tabulated the species from seven Pleistocene and thirteen Holocene localities. There is also a column showing the species which occur in Pliocene deposits, and another giving all the living British species. Of the 139 living species no less than 129 occur in the south of England, and of the ten extinct forms seven have been found in the same area. The authors have expressed their opinion that the Pleistocene molluscan fauna was a finer one than that of to-day. The non-marine Mollusca have reached this country from various sources. In their opinion a large number are boreal, and of these some travelled hither along the now sunken land to the north of Scotland, whilst others may have journeyed through Siberia and the Continent; some have come from the south by the old land connection between England and the Continent; while others, the so-called Lusitanian forms, have reached us from south-west Europe; a few species may be endemic. Some changes in nomenclature are noted, but the authors justly remark that the identity of the shell is of more

importance than the absolute correctness of the name from a "priority" point of view.

IN *Publication* No. 56 of the Field Columbian Museum Dr. G. A. Dorsey describes the results of a fortnight's digging in the island of La Plata, Ecuador. It seems probable that for a very long period the island was visited by people from the mainland for ceremonial purposes, as none of the pottery appears to have had any utilitarian use, practically all being of the nature of images of the human form ranging in height from six to twenty inches, and most of them were provided with whistles. There were found numerous engraved and plain rectangular and circular discs and other problematical objects. In a tongue of detrital soil near the shore was found a grave which, from its contents, belonged to another occupation of the island, and there can be little doubt that invaders from Peru previous to the Spanish conquest were buried in this little island so remote from their home. In the grave excavated by Dr. Dorsey were found two gold human figures, one of silver, one of bronze and one of copper, besides a gold cup and several objects in gold, silver and copper, twelve earthenware vessels and a magnificent ceremonial highly polished stone axe, 19½ inches long and less than three-quarters of an inch thick, which may be considered as one of the most remarkable stone implements ever found. The paper is illustrated with sixty-three excellent plates and several figures. The letterpress is exceptionally condensed; a little more amplification would have been an improvement, and the sizes of the objects should have been given. An English observer fails to see why what appears to be a very evident alligator which surmounts a fragment of a human head in pottery should be termed a "serpent head-dress." The prominent valvular nostrils, the character of the eye, the keeled dorsal scutes and the limbs are essentially crocodilian, as is also the prominent lateral tooth in the upper and *lower* jaw; the latter cannot be the "projectile fangs of a serpent."

AT a recent meeting of the Linnean Society, Prof. S. H. Vines gave the results of his recent investigations of the proteolytic enzymes of plants, especially that of the pitchers of Nepenthes. The application of a chemical test—the pink or violet colour produced by the addition of chlorine water—shows that the enzyme in Nepenthes is tryptic, and not peptic; and this is probably the case with all ferments found in the vegetable kingdom. Prof. Vines proposes the term nepenthin for the ferment of Nepenthes.

THE *Journal* of the Royal Microscopical Society for December, 1901, contains the usual annual list of new biological terms (zoology and botany) introduced during the year. In the *Transactions* of the Society is a paper by Miss A. Lorrain Smith, on work carried on in the laboratory of the Royal Agricultural Society, on fungi found on farm seeds when tested for germination. A new genus of fungi, Stemphyliopsis, is described.

THE bulky part of the *Journal* of the Royal Horticultural Society for December contains a full report of the Lily conference held in the Gardens at Chiswick on July 16, 1901. The wide spread of the lily-cult is shown by the fact that at that meeting no fewer than eighteen papers were read, on the culture of lilies, their species and varieties, their diseases, &c. The most important original paper in this number is one by Sir James Blyth, on vine culture as exemplified at the Paris Exhibition.

THE Imperial Department of Agriculture for the West Indies has just published pamphlet series Nos. 12 and 13. The former, "Seedling and other Canes in the Leeward Islands, 1900–1901," is a summary of the report on sugar-cane experiments conducted at Antigua and St. Kitts recently noted here. The other, "Seedling and other Canes at Barbados, 1901," is a summary of an address delivered to the Barbados Agricultural Society by Prof. D'Albuquerque and Mr. Bovell, giving the results of the experimental cultivation of selected canes during last year. In the earlier stages of the experiments the weather seems to have been all that could be desired, and things looked so promising that a bumper crop was predicted; but at the critical moment, when good rains were essential for the complete fulfilment of the prediction, an all but universal drought settled down on the island and lasted until the canes were reaped. When the harvest time arrived the wind dropped so light that the windmills could not be worked. The canes were therefore growing long after they ripened, and when cut they were often standing some days at the mill door waiting for the wind to crush them. This combination of adverse weather had much to do with the poor quality of sugar that in many instances was turned out for sale. Seedling B. 208 proved the best all-round cane, the indicated muscovado sugar yield being 2·6 tons per acre (being second in 1900 with 3·02 tons). White Transparent was second with 2·5 tons (in 1900 it was eighth with 2·41 tons), and B. 147 third with 2·4 tons (in 1900 first, with 3·1 tons). B. 156, B. 306, B. 347 and Rock Hall cane produced impure juice and D. 130 and D. 145 yielded such a small tonnage of canes that their further experimental cultivation is undesirable.

MESSRS. PENROSE AND CO. have sent us a copy of their new, strongly bound and most luxurious catalogue of their apparatus and supplies, which contains particulars of almost every appliance or material known to be used in photo-mechanical processes, and is the most complete catalogue of process appliances with which we are acquainted. The book, which consists of 272 pages of matter printed on excellent paper, contains also 750 illustrations, many of which are by the half-tone process, and there are also 1260 references in the index. It may be added that the catalogue is supplied free of charge to regular customers and will be sent to prospective customers on receipt of half a crown, which will be refunded on the first order for goods to the value of one pound or upwards.

A VALUABLE collection of books and tracts on pure mathematics exists in the Central Library, Newcastle-upon-Tyne, and the catalogue prepared by Mr. Basil Anderton, chief librarian, and just issued by the Newcastle Public Libraries Committee, should be the means of making the collection more widely known than it is. Only works on purely mathematical problems are included, but the extent of the collection may be judged by the fact that the titles of such books and tracts in the reference library occupy forty-five closely printed quarto pages. The works are arranged alphabetically according to authors, and, so far as possible, related writings by the same author have been brought together. The committee of the Library is anxious that the books should be abundantly used, and the catalogue has been issued with this end in view.

THE Annual Report of the Smithsonian Institution for 1900 was received a few days ago, and, like the reports of previous years, it is a volume which commands admiration. The account, given by Dr. S. P. Langley, of the position and progress of the Institution occupies 117 pages and is naturally of restricted interest; but following it are no less than forty-three papers, occupying 643 pages, with numerous plates, selected from the scientific publications of the year because of their importance in illustrating directions of scientific thought, and containing trustworthy accounts of progress in physical and biological discovery. It is scarcely too much to say that every subject in which the world of science is interested finds its way in the course of time into Dr. Langley's comprehensive repertory. The articles which are reprinted or translated are chiefly by men of science of first

rank engaged in the extension of natural knowledge. The present volume contains reports upon scientific work, as, for example, those by Dr. Langley upon observations of the solar eclipse of May 28, 1900, the new spectrum, and the Langley aërodrome; scientific articles from magazines, as Sir Norman Lockyer's account of the progress of astronomy during the nineteenth century, Prince Kropotkin's article on unsuspected radiations, and the late Dr. J. Fiske's reminiscences of Huxley; presidential addresses, as Prof. W. J. Sollas's address on evolutional geology, delivered before the British Association in 1900, and Dr. G. M. Sternberg's address on malaria; several papers read before scientific societies, as one by Prof. V. B. Lewes on incandescent mantles, and Mr. E. S. Grogan's paper, read before the Royal Geographical Society, on his journey through Africa from the Cape to Cairo; original articles on Chinese folklore, and the restoration of extinct animals, and several translations, among which we notice a paper by Dr. Janssen on the progress of aëronautics, and one by Dr. F. Delitzsch on discoveries in Mesopotamia. In addition to these articles there are a number of others dealing with the progress of various branches of science during the nineteenth century. We are grateful to Dr. Langley for collecting these contributions to scientific literature from many sources and rendering them easy of access in his annual anthology.

THE additions to the Zoological Society's Gardens during the past week include a Bonnet Monkey (*Macacus sinicus*) from India, presented by Mr. L. E. Carmalt; a Macaque Monkey (*Macacus cynomolgus*) from India, presented by Mr. W. H. Sheridan; a Black-eared Marmoset (*Hapale penicillata*) from South-east Brazil, presented by Mrs. Augusta Ryland; a Common Squirrel (*Sciurus vulgaris*), British, presented by Mr. R. B. Hatfield; a Red-faced Spider Monkey (*Ateles paniscus*) from Guiana, a Barnard's Parrakeet (*Platycercus barnardi*) from South Australia, five Conical Eryx (*Eryx conicus*), a Long-snouted Snake (*Dryophis mycterizans*), a Hamilton's Terrapin (*Damonia hamiltoni*) from India, two Black-headed Terrapins (*Damonia reevesi unicolor*) from China, deposited; two Coscoroba Swans (*Coscoroba candida*) from Antarctic America, purchased.

OUR ASTRONOMICAL COLUMN.

THE ANNULAR ECLIPSE OF THE SUN, NOVEMBER 11, 1901.—The successful observation of this eclipse by M. A. de la Baume Pluvinel at Cairo was announced by telegram some time ago, and his complete report of the operations appears in the *Comptes rendus* (vol. cxxxiii. pp. 1180–1185). Although the results were in general successful, the conditions were somewhat unfavourable owing to the low altitude, about 15°, of the sun at mid-eclipse.

Three lines of investigation were attempted.

(1) The examination of the solar spectrum at grazing incidence on the moon's surface. This was done with a powerful grating spectrograph, using an image of the sun about 14 mm. diameter on the slit plate. No variation in the various groups of lines examined could be detected, and it was concluded that this rendered the existence of any lunar atmosphere extremely improbable.

(2) Photographs of the crescents presented at second and third contacts were obtained in the hope of detecting any difference in constitution between the chromosphere and the outer photospheric layers. These were taken with a small prism spectrograph, having condenser, collimator, and camera objectives all about 0·60 metre focal length. A considerable number of arcs were obtained, and a list is given showing their wave-lengths in comparison with Young's chromospheric lines. The main series of arcs corresponded to a chromospheric layer about 20″ of arc in height, but beside these there appeared a series of more feeble images corresponding to a layer some 40″ high. The absence of the hydrogen series so conspicuous in the chromospheric spectrum is attributed to the mutual action of chromospheric radiation and photospheric absorption.

(3) Attempts to photograph the corona in presence of sunlight. This had appeared feasible in consequence of the impressions obtained several seconds after totality during the eclipse of January 1898, in India. For this work he employed a Cooke triple photo-visual objective of 1·5 ometres focal length. This instrument and the image lenses of the two spectrographs were fed by 3 plane mirrors mounted on a single cœlostat.

As the diameters of sun and moon differed by 1′ 24″ there were about 16/100ths of the sun's disc still visible at mid-eclipse. Two photographs, with 3 seconds and 10 seconds exposure, were obtained, but the aureole shown is not thought to be truly coronal.

Attempts were also made to detect the corona by utilising the action of the calorific rays on phosphorescent substances, but with negative results.

THE MAMMALS OF NORTH AMERICA.

AMONGST the recently issued publications of the Field-Columbian Museum of Chicago we find a list of the land and sea mammals of North America, north of Mexico, prepared by Mr. D. G. Elliot, curator of the department of mammals in that institution. The list is stated to contain the names of all the forms of North American mammals found on land or in the adjacent seas which had been described up to the date of publication (June 10, 1901), at any rate all those that "under the most lenient treatment are entitled to any sort of consideration." This most useful catalogue serves to show us very plainly the great activity of the American zoologists in this particular department of their science during recent years. In the late Prof. Baird's work on North American mammals, published in 1857, only 220 terrestrial species of this class (not including the bats) were recognised as occurring in the northern portion of the American continent, besides thirty-six others which were considered as of doubtful authenticity. Mr. Elliot's list contains the names of 628 species besides 368 subspecies, so that, if we take it as correct, the number of recognisable forms of North American mammals has been enormously increased of late years. It will be interesting to ascertain in what groups of the class of mammals this great augmentation has mainly taken place. This is shown in the following tabular statement:—

	Elliot, 1901			Baird, 1857
	Sp.	Subsp.	Total	Sp.
Order i. Marsupialia	2	1	3	2
,, ii. Edentata	1	—	1	1
,, iii. Sirenia	2	—	2	—
,, iv. Cetacea	46	2	48	—
,, v. Ungulata	25	11	36	15
,, vi. Rodentia	380	255	635	130
,, vii. Carnivora	88	62	150	46
,, viii. Pinnipedia	14	—	14	—
,, ix. Insectivora	47	22	69	26
,, x. Chiroptera	23	15	38	—
	628	368	996	220

In considering these figures it must be remarked that as Baird did not include the three groups of marine mammals or the Chiroptera in the scope of his work no complete comparison can be made. But it will be obvious, on a glance at the comparative tables, that it is the smaller mammals, the Rodents and Insectivores, that have so greatly increased in multitude, according to the present fashion of dealing with them. The Rodents, of which Baird only recognised 130 in North America, are now supposed to number 380 species, besides 255 subspecies,

and the Insectivores have risen from 26 species to 47 species and 22 subspecies. It is, of course, only natural that a considerable increase of species should have taken place in both these groups, as numerous and active collectors sent out by the United States National Museum and by the Agricultural Department at Washington have of late years traversed every part of the large western States and the adjoining districts of Mexico, where the members of these two groups are found in abundance. The collections thus made have been worked out by Dr. C. Hart Merriam, Mr. Allen and other well-known American naturalists, who have specially devoted their energies to the study of these groups of mammals. It may be fairly stated that in the opinion of many naturalists (who perhaps in these days would be pronounced to be somewhat old-fashioned) the process of the subdivision of species (vulgularly called "splitting") has, in some cases, been carried too far, especially as regards subspecies. At the same time there is no doubt about the high character of the work executed so diligently by Dr. Merriam and his *confrères*. We may point out, however, that the same kind of subdivision has been carried on also, to a certain extent, amongst the larger mammals. On turning over the pages of Mr. Elliot's "List" it will be noticed that the reindeer (*Rangifer*) of North America, which the old-fashioned naturalists have hitherto classed as being specifically inseparable from the European form (*R. tarandus*), is now held to consist of seven different species, and that the Rocky Mountain sheep, of which, until lately, only a single species was generally recognised, has been split into four or five species. Referring to the Carnivora, we find the southern lynx (*Felis rufa*) divided into nine subspecies, and the Virginian fox (*Canis virginianus*) into seven subspecies. The bears of North America, according to Mr. Elliot's "List," now consist of nine species, besides three subspecies. We in Europe have been accustomed to refer them all to three species only. In a similar way the skunks of North America (*Mephitis*) of which Baird only recognised five species, are now held to number no less than twenty species and four subspecies, divided into three genera.

What we have stated (to which more remarks of a similar character might easily be added) will serve to show that a great revolution is now taking place in the mode of treating the mammals by American workers. Symptoms of the same class of work have also occurred in Europe, but the process has not been carried on here to so great an extent, nor has it met with such general acceptance. Whatever may be its results it will certainly be necessary to add greatly to the space now occupied by the mammals in museums of natural history, for it is only a very large series of specimens that will enable the conscientious student to decide between the opposing claims of the "splitters" and the "lumpers," and to decide what are species and what are subspecies.

PRIZE SUBJECTS OF THE PARIS ACADEMY OF SCIENCES.

THE *Comptes rendus* of the Paris Academy of Sciences for December 16, 1901, contains a list of the prizes proposed for the years 1902, 1903. 1904, 1905 and 1906. The subjects proposed for the current year include the following :—

Geometry.—The subject proposed for the grand prize of the mathematical sciences is to perfect, in an important point, the application of the theory of continued groups to the study of partial differential equations; for the Bordin prize (3000 fr.), to develop and perfect the theory of surfaces applicable to the paraboloid of revolution; the Francœur prize (1000 fr.) and the Poncelet prize (2000 fr.) will be awarded for works useful to the progress of pure or applied mathematics.

Mechanics.—The Plumey prize (2500 fr.) for an improvement in the steam engine or any other invention contributing to the progress of steam navigation; a Montyon prize (700 fr.) for invention or improvement of instruments; extraordinary prize of 6000 fr. for any invention tending to improve the efficacy of the French naval forces.

Astronomy.—The subject announced for the Damoiseau prize (1500 fr.) is the completion of the theory of Saturn as given by Le Verrier, publishing the rectifying formulæ and establishing the agreement between theory and observation; the Janssen gold medal for an important discovery in physical astronomy; and the Lalande (540 fr.) and Valz (460 fr.) for general work in astronomy.

Geography and Navigation.—The Binoux prize (3000 fr.) will be awarded for the best work on this subject.

Physics.—The Hébert prize (1000 fr.) for a practical application of electricity.

Statistics.—A Montyon prize (500 fr.) for a memoir on the statistics of France.

Chemistry.—The Jecker prize (10,000 fr.) for work tending to the progress of organic chemistry.

Mineralogy and Geology.—The Fontannes prize (2000 fr.), to the author of the best palæontological publication.

Physical Geography.—The Gay prize (2500 fr.) for a memoir on the progress realised in the nineteenth century in the study and representation of the earth.

Botany.—The Desmazières prize (1600 fr.) will be awarded, independently of nationality, to the author of the best work on cryptogams; the Montagne prize (500 fr.) for a memoir on the anatomy, physiology or development of the lower cryptogams.

Anatomy and Zoology.—The Savigny prize (1500 fr.) for the assistance of young travelling zoologists, not receiving Government assistance, who occupy themselves especially with the invertebrates of Egypt and Syria; the Vaillant prize (4000 fr.) for the study of the fauna of an Antarctic island of the Indian Ocean; the Thore prize (200 fr.) for the best work on the habits and anatomy of a species of European insect.

Medicine and Surgery.—A Montyon prize for works useful in the art of healing; the Barbier prize (2000 fr.) for a valuable discovery in surgical, medical or pharmaceutical science; the Breant prize (100,000 fr.) for the discovery of a radical cure for Asiatic cholera, or for indicating in an indisputable manner the causes of Asiatic cholera in such a manner as to lead to its suppression, or, failing this, the interest on the capital sum will be awarded for a rigorous proof of the existence in the atmosphere of matter capable of taking part in the production or propagation of epidemic diseases, or for the discovery of a radical cure for herpes or for clearing up its etiology; the Godard prize (1000 fr.) for the best memoir on the anatomy, physiology or pathology of the genito-urinary organs; the Serres prize (7500 fr.) for the best work on general embryology, applied, as far as possible, to physiology and medicine; the Bellion prize (1400 fr.); the Mège prize for an essay on the causes which have retarded or favoured the progress of medicine from the oldest times to the present day; the Lallemand prize (1800 fr.) for work on the nervous system; and the Baron Larrey prize (1000 fr.) for the best work presented to the Academy treating of military medicine, surgery or hygiene.

Physiology.—A Montyon prize (750 fr.); the Pourat prize (1400 fr.) for a memoir on the comparative study of the mechanism of respiration in mammals; the Martin-Damourette prize (1400 fr.) and the Philipeaux prize (880 fr.) for work in experimental physiology.

General prizes.—The Arago medal is awarded by the Academy in recognition of a work or discovery of the first rank; the Lavoisier medal is awarded without distinction of nationality to chemists who have rendered eminent service to their science; a Montyon prize (unhealthy trades) for discoveries or inventions diminishing the dangers of any unhealthy trade; the Wilde prize (4000 fr.), awarded without distinction of nationality, for that work or discovery which, in the opinion of the Academy, is best worthy of recompense in astronomy, physics, chemistry, mineralogy, geology or experimental mechanics; the Tchihatchef prize (3000 fr.) for exploration in the lesser-known parts of Asia; the Delalande-Guérineau prize (1000 fr.) for services rendered to French science; the Jérome Ponti prize (3500 fr.); the Houllevigue prize; the Cahours prize (3000 fr.) for the encouragement of young men already known for their work, especially in chemistry; the Saintour prize (3000 fr.); the Trémont prize (1100 fr.); the Gegner prize (3800 fr.); the prizes founded by Mme. la Marquise de Laplace and by M. Félix Rivot.

Of these prizes some are explicitly and others tacitly restricted to Frenchmen; among those expressly stated to be offered without restriction of nationality are those bearing the names of Leconte, Tchihatchef, Wilde, Lavoisièr, Arago, Desmazières, Delesse, La Caze, Lalande and Pierre Guzman.

PHOTOGRAPHS OF SNOW CRYSTALS.

MR. W. A. BENTLEY, of Jericho, Vermont, U.S.A., has devoted twenty years to the study of snow crystals, with special reference to the relation between their forms and the atmospheric condition at the time of their fall. He gives in the U.S. *Monthly Weather Review* a short account of the results of his investigations; and a number of beautiful reproductions of photomicrographs of snow crystals secured by him accompany his paper. By the courtesy of Mr. Willis L. Moore, chief of U.S. Weather Bureau, we are able to give several of these pictures and an abstract of Mr. Bentley's contribution referring to them. So far as we are aware, no more beautiful or complete collection of photographs of snow crystals has ever been obtained than that produced by Mr. Bentley's patient work, and the fact that he has prosecuted his studies in somewhat difficult circumstances for so long is an excellent testimony to his scientific enthusiasm. We understand that he is preparing a volume upon the photographs, and the results of his studies of them. An album containing prints of all his drawings and photographs, with a short description of the methods and conclusions, would certainly be of great scientific value. The following notes are abridged from his paper in the *Monthly Weather Review*.

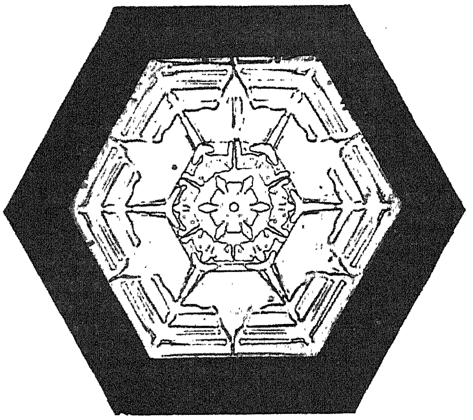


FIG. 1.—1895, February 8. Wind north-west, temperature −4° F.

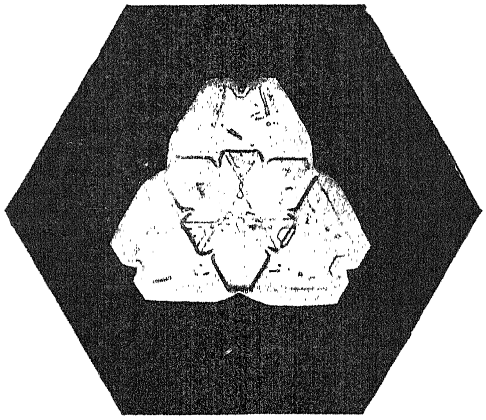


FIG. 2.—1900, February 18. Wind west to north-west, temperature 11°.

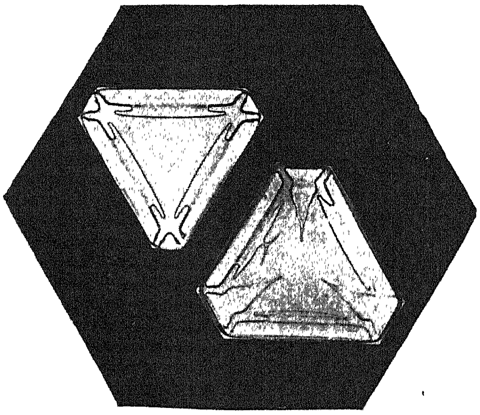


FIG. 3.—1899, February 13. Wind north, temperature 1°.

Photographs have been secured during every winter since 1884, and they now number more than 800, no two alike. Nearly every great and famous winter storm since that date has furnished its quota of from four to twenty (and in one instance thirty-four) of new forms to this collection. At the same time, observations have been made and data secured, while photographing them, of the temperature; kinds and approximate heights of clouds (when possible); the direction and rapidity of movement of various cloud strata; the direction and velocity of the surface winds; also changes in the forms of the crystals form hour to hour as the different portions of each storm passed over the district. The latter observations were made to ascertain whether there was any general law of distribution of the forms within the different portions of a storm. Differences in form of crystals deposited by local storms from those of general storms were also noted, as also

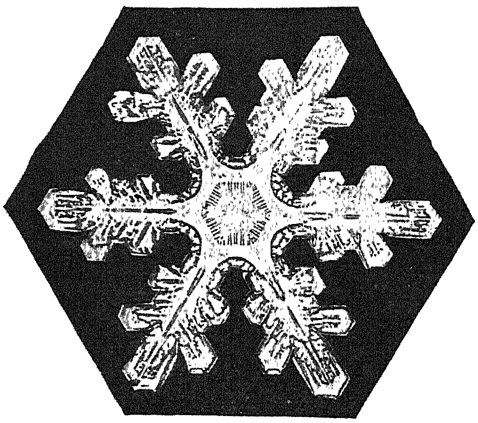


FIG. 4.—1900, December 5. Wind north-west to north, temperature 22°. Cloud, stratus.

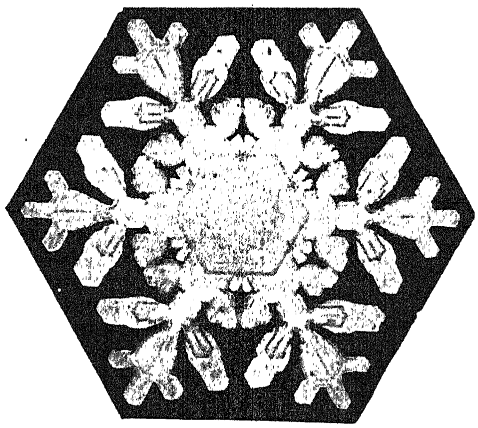


FIG. 5.—1888, March 12. Great blizzard, temperature 12°. Diameter one-quarter of an inch.

the forms originating in, and peculiar to, each of the various cloud strata. These observations, and the data secured, indicate that the temperature and the humidity of the air at the earth's surface is a much less important factor than is generally supposed in determining the form and size of humidity due to these; the character of the storm, whether local or general, and the portion of the storm region from which the crystals come. To these must also be added the initial and subsequent movement of the crystals within the clouds. If, as must often be the case, the nuclear forms originating in the

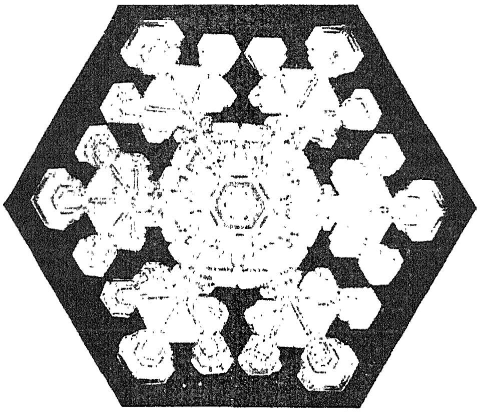


FIG. 6.—1901, February 15. Wind north-west, temperature 14°.

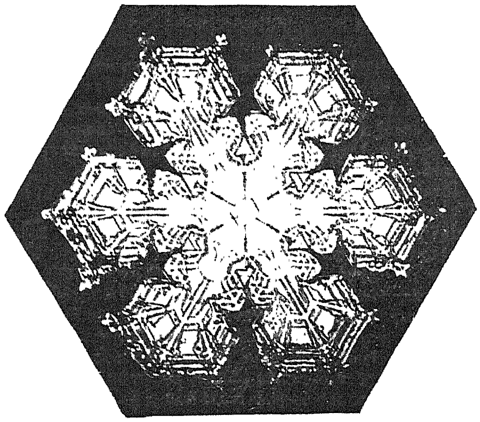


FIG. 7.—1898, January 26. Wind changing west to north-west, temperature 18°.

the crystals. We may easily conceive this to be the case, because at a given temperature, &c., at the earth's surface, the temperature and humidity of the air where the crystals form might vary greatly, one time from another, and would depend largely upon the height of the snow-producing clouds. The height of these varies greatly at different times, even when the temperature at the earth's surface remains the same. The data secured have not revealed the great mystery of the origin and cause of the differences in the forms of the nuclei; why columnar forms predominate at one time, tabular forms at another, or why both are sometimes found associated together. Much has been learned, however, of the conditions tending

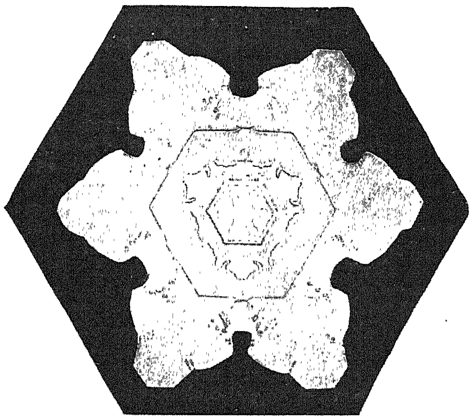


FIG. 8.—1899, January 6. Wind south-south-east, temperature 22°. Clouds, upper stratus.

lower ascending clouds are carried upward to much greater heights by the strong ascending air currents, which often occur within such storms, until they become heavy enough to fall back through them, then the crystals will in all probability be greatly modified by passing through atmospheric strata varying greatly in density, temperature, humidity, &c. That they are greatly modified by these flights in the clouds is clearly shown by the interior structure of many of the crystals outlining many of these transitory states. Thus, crystals of which the nuclear form was originally nearly perfectly hexagonal sometimes become partly triangular in outline, and *vice versâ*. No. 8 is an example of such modifications.

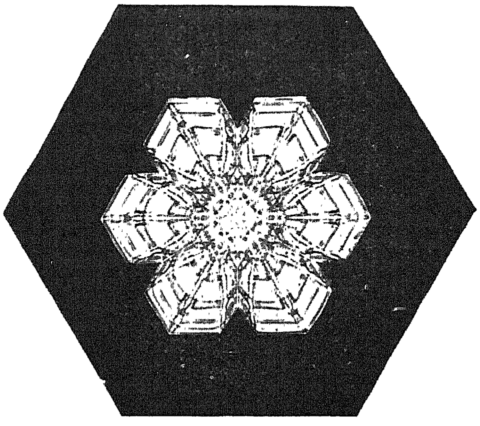


FIG. 9.—1886, February 26. Wind north-west, temperature 8°.

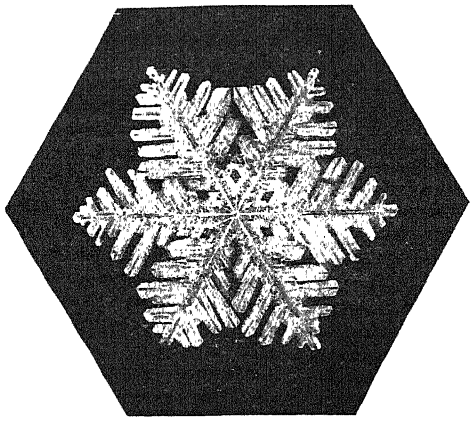


FIG. 10.—Wind west, temperature 34°.

to modify their forms after the nuclear form is once organised. These conditions are many, the chief among them being the height, number and vertical depth of the cloud strata and the resultant variation in temperature, atmospheric pressure and

Perhaps the most important facts of a general nature to be gleaned from twenty years' study are these:

(1) That the greater number of the more perfect and beautiful tabular forms occur much more frequently in, and are confined

almost wholly to, the western and north-western portions of great storms and blizzards.

(2) That there seems to be a law of general distribution of the different forms, the columnar to one, the tabular and granular to others, with many varieties associated together in other portions of such great storms.

(3) That this distribution is, with few exceptions, constant, that is, the same in nearly all storms.

Sufficient data has not as yet been collected to demonstrate beyond all doubt the fact that this law applies to all forms of crystals and to all storms alike.

Passing on to the variation in form of those crystals deposited by local storms, as compared with those of general storms, we find that these are very marked, except during intense cold.

The local storm types and those precipitated from low, detached clouds usually consist of large, frail, branching, tabular forms, devoid of a solid tabular nucleus (see No. 10), or of heavy granular varieties, similar one to the other, each according to its class. On the other hand, those deposited by general storms are usually more diversified in form and more complex in structure, the snowfall often consisting of two or more varieties associated together. The larger and more perfect columnar prisms, columnar forms possessing tabular outgrowths at one or both ends (which we might call doublets), truncated triangular forms (see Nos. 2 and 3), and solid tabular forms, the latter often possessing wonderfully beautiful and complex interior designs (as in No. 1), are common only to general storms. Branching tabular and granular forms are common to both general and local storms, but they ordinarily possess solid nuclei if deposited from a general storm (as in Nos. 4–7), whereas the nuclei are generally absent (as in No. 10) if the crystals originated in local storms. During zero weather the crystals of local storms approach much nearer in form to those of general storms, and we find solid tabular forms, branching tabular forms possessing solid hexagonal nuclei and sometimes doublets, among the snowfall. Often during the intense cold succeeding a blizzard the snowfall will consist wholly of very minute columnar and pyramidal forms, or of both columnar and minute frost-like tabular forms, falling apparently from low, detached nimbus or alto-nimbus clouds, or even from a sky free, or nearly so, of clouds.

During relatively mild temperatures each cloud stratum, if alone, there being no other clouds either above or below them, commonly precipitates each its own peculiar type of crystals. Low detached nimbus clouds deposit large, frail, branching tabular forms, similar to No. 10; intermediate clouds, smaller, branching tabular forms, possessing solid hexagonal nuclei; and the high cirro-stratus clouds, small compact columnar and tabular forms. The large cumulus clouds of spring and autumn usually shed large, heavy, pyramidal-shaped granular snow. These granular forms frequently, if not invariably, possess nuclei of branching, tabular forms, and are usually precipitated when the temperature is near or somewhat above the freezing point.

Of the photomicrographs which accompany this article all, with the exception of No. 10, are those common to and were deposited by great storms.

Of the other numbers of the series, No. 2 is very rare and unusual, containing as it does eleven triangular divisions within its outlines. Apparently the lines of greatest growth were reversed during one stage of the growth of this strange form, thus differing widely from No. 3, which has outlines somewhat similar. No. 4 possesses a very rare unique nuclear design which is very difficult to explain by any process of crystallisation of which we know. No. 5 (a souvenir of the great blizzard of March 12, 1888) is very symmetrical, as also is No. 6, of February 15, 1901. No. 7 is, in all but the unimportant outermost points, a marvel of complexity and perfect symmetry. No. 9 is also a marvellously beautiful and symmetrical example of snow architecture.

Passing to the causes governing the formation of the nucleus, whether it be columnar or tabular, the electrified state of the atmosphere, whether negative or positive, and perhaps, also, as suggested by Prof. Cleveland Abbe, the presence in greater or less amounts of various gases and vapours in the atmosphere, may all be controlling factors.

Although much has been already learned about these interesting phenomena, yet there still remains much more. Cooperation between many observers is essential to carry out this work successfully. Simultaneous observations of the forms and changes the crystals undergo from hour to hour during our great blizzards should be made by many skilled observers, stationed along a general line extending north and south. These observers must be familiar with the names and approximate heights of the various clouds. This study should include observations of the kind and approximate height and direction of drift of the various clouds, direction and force of the surface wind, temperature of the air, and amount of moisture at the earth's surface; also its electric condition, whether negative or positive, and the portion of the storm from which the crystals emanate.

It is also highly desirable that observations be made to ascertain why the perfect crystals are more common in the western portion of storms, and also why certain portions produce certain types.

Such a study, supplemented by investigations as to the causes of the formation of the two fundamental types of hoar-frost crystals, would doubtless lead to the discovery of very many of the mysteries surrounding the origin and history of the wondrously beautiful forms of snow.

A NEW JOURNAL OF ANATOMY.

THE first number of a new scientific magazine—*The American Journal of Anatomy* (Baltimore, November 1901)—has been received and merits a descriptive notice because, as it has been "founded to collect into one place, and present in a worthy manner, the many researches" of American anatomists, it marks a new departure in scientific journalism, and while its pages are but 98 in number we are informed that future issues will be in quarterly parts of about 125 pages each. The interest with which British anatomists regard their branch of science as practised in America has during the last four to five years been heightened by the association, as joint editor of our own long-established *Journal of Anatomy and Physiology*, of Prof. G. S. Huntington, of the Columbia University at Washington, who is one of the chief promoters of the new journal now under review. The reason of this enhanced interest lies in the fact that his connection with the English publication was marked by the appearance in its pages of a paper of a kind to which its readers were unaccustomed. It deals with a series of sections of an early human embryo, and while containing nothing that is new, surpasses all precedent in being illustrated by 11 plates of photomicrographic figures which do not portray a single fresh fact and can only be defined as useless. When, further, it is observed that the paper (by an English author) which immediately followed this in order of publication was similarly granted 12 plates, where 4 might well have sufficed, there is no wonder that there arose in the minds of the supporters of the journal a misgiving, lest the new association might perhaps lead to disaster. Let it be said, however, that American papers since received have been of a more normal kind.

This consideration lends interest to the circumstance that in the journal under review one of the five papers submitted monopolises 37 of the 98 pp. which make up the issue, as well as the whole of the 9 plates and 27 of the 42 text figures. It deals with a series of human embryos, as illustrating "The Development of the Limbs, Body-wall, and Back, in Man," and is a joint production by Drs. C. R. Barden and W. H. Lewis, of Baltimore. It is carefully written, and of the illustrations no praise can be too high. But we deplore the fact that, beyond the more exact determination of the actual period at which some of the important constituents of the developing nervous system and parts of the fore- and hind-limbs are first differentiated, there is nothing either recorded or delineated in it which is new. As a chapter for a text-book it would be well-nigh ideal; but in a journal devoted to records of research and new observations it is out of place and does but hamper the way.

We wish no disrespect to the authors, for if, as we assume, in providing the positively magnificent illustrations, they have but availed themselves of the condition set forth in the editorial advertisement, "that the cost of more expensive plates must be borne in part by the authors," we would rather tender them our hearty thanks. While, however, we would thus appraise their enterprise and artistic taste, we are still of opinion that, if our surmise is correct, both these and their enthusiasm have been misapplied; for if we are to proceed on these lines, the danger, at present obvious enough in all departments of anatomical

inquiry, of the science becoming buried in its own literature will be rendered unavoidable. Of the other papers which fill the remaining 61 pp. of the issue before us there are four. One by Dr Preston Kyes, of Chicago, on "The Intralobular Framework of the Human Spleen," contains little that is new, and is chiefly noteworthy for the introduction of a method. Then follows a paper entitled "Studies on the Neuroglia," by Dr. Carl Huber, of Michigan, which embodies a useful *résumé* of the conflicting results of the observations of previous investigators. The author has adopted the comparative method of inquiry, and has done good service in relation to technique; and among his chief results is the conclusion that certain of the neuroglia fibres are not simply processes of the cells, or, as von Kölliker believed, of a differentiated cell-plate, but that they are to be regarded as intercellular.

The fourth paper is welcome, as dealing, in an up-to-date manner, with the modern topic of "The Normal Histology of the Human Hæmolymph Glands." Its author, Dr. A. S. Warthin, also of Michigan, gives it as his opinion that our conceptions of lymphoidal tissues are greatly broadened by the study of these glands. He distinguishes between "spleenolymph" and "marrowlymph" glands, on a basis of structural and functional differentiation. He defines the latter as retroperitoneal, and in many observed cases most prominent when associated with pathological conditions. He admits the existence of transitional types of gland, and suggests that the ordinary lymphatic gland is the most highly developed, and that the spleen stands in similar relationship to it through the spleenolymph gland as does the lymphoid marrow through the marrowlymph gland. He further regards the red marrow as "the most primitive type of lymphoid structure."

The fifth and last paper is by Prof. C. S. Minot, of Harvard Medical School, who needs no introduction to English anatomists. It is "On the Morphology of the Pineal Region, based upon its Development in Acanthias," and is a very careful study, mainly of the paraphysis and velum. Six "fundamental morphological divisions" are recognised "in the median line of the diencephalic roof," and for some of these new terms are proposed. It is pointed out, on a delimitation of that which the author terms the "paraphysial arch," as distinct from the "post velar," that the posterior commissure belongs morphologically to the mid-brain. The paraphysis is regarded as in all probability a true gland, akin to the infundibular gland and the glandular epiphysis of birds; and it is suggested that these are severally comparable to ductless glands, and that they "supply some substances which are useful to the nervous system."

The journal is well supported, and its get-up is deserving of the highest praise. Its collaborators include the names of more than sixty persons, most of whom are either leaders in human and comparative anatomy in the United States or otherwise well known, and its editorial board is composed of eight of their number who are sufficiently representative. On the whole, we would congratulate our friends upon their venture; and if they will only see to it that, whenever possible, they rest content to work upon a basis of the bare record of facts hitherto unobserved, whereby they will not burden an already overcrowded literature, we can at least assure them of our sympathy and good wishes, if not our actual support.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

LORD Strathcona, the Lord Rector of the University of Aberdeen, has sent a cheque for 25,000*l.* towards the Aberdeen University building scheme, the public having subscribed 30,000*l.* and thereby more than fulfilled the condition under which Lord Strathcona promised his gift.

THE Prince of Wales has consented to visit Manchester on March 12 to open the Whitworth Hall at the Owens College. At a meeting of the Court of Governors of the College on Tuesday, the following motion was passed:—"That the time has arrived when steps should be taken to secure that there should be, as originally proposed by the Owens College, an independent University in Manchester."

THE annual meeting of the Geographical Association will be held at the College of Preceptors on Wednesday, January 15. Mr. Douglas W. Freshfield, president of the Association, will occupy the chair, and an address will be delivered by the Right Hon. James Bryce, M.P., on "The Importance of Geography in Education." Tickets may be had on application to the hon. sec., Dr. A. J. Herbertson, 9, Staverton Road, Oxford, or to the hon. treas., Mr. J. S. Masterman, St. Margaret's, Dorking.

THE system of teaching by correspondence is not one which has attained to very great favour in this country, except, perhaps, as a means of preparing for examinations, and it would be considered by most especially unsuitable for studying such preeminently practical professions as civil, mechanical and electrical engineering, mining, &c. Yet it appears from an article in a recent number of the New York *Electrical Review* that this system has a considerable vogue in America. The International Correspondence Schools, in spite of the fact that they were only inaugurated ten years ago, now number more than 350,000 students, amongst whom a large proportion are following courses in engineering, and it is not the only institution of the kind in the States. A decidedly valuable feature of the system in the case of the electrical courses is that students are supplied with sufficient apparatus to carry out most of the fundamental experiments. No doubt this method of teaching can be of great benefit to those who are actually employed in engineering works and are thus more or less conversant with the practical side of the subject, and in consequence can be of considerable help in raising the efficiency of the country, which must ultimately depend on the efficiency of its workers.

A PAPER on German Technical Schools by Prof. V. C. Alderson, Dean of the Armour Institute of Technology, published in the *Chicago Inter Ocean*, contains some points which serve to accentuate the account given in last week's notes (p. 213) of the little that is being done for higher technical education in Great Britain. Prof. Alderson describes briefly the Technical High Schools at Charlottenburg, Karlsruhe, Munich, Hanover, Darmstadt and other German cities, and compares the work carried on in them with that of the technical schools in the United States and Great Britain. He points out as a lamentable fact that the provision for engineering education in London is totally inadequate. "In this great city of 6,000,000 people barely 600 students a year are provided with engineering instruction of an advanced character. In this great metropolis, which contains more engineers of every class than any other city in the world, and where there is the greatest demand for their services, not only at home, but in foreign enterprises financed in London, the provision for their education is comparatively nothing. Any one of the German Technische Hochschulen which I have described, with far less reason for existence, has a larger equipment, is more expensive to maintain, covers a broader field of work, and is better fitted to exert a powerful influence upon the profession and the industries than the best technical school in London. Not only are the few schools now in the field inadequate for the purpose, but many fields of engineering education are entirely bare. Absolutely no provision is made for teaching marine engineering, naval architecture, railway engineering, municipal engineering, or architecture. These are departments of the utmost consequence for the continued prosperity of London, yet she allows her young men to pick up their training in the old-fashioned way, and if she needs a really capable man she must import him from Germany, Switzerland or America. London has received no greater shock recently than to wake up and find that the equipment of the new 'twopenny tube,' as the Electric Railway is called, was almost entirely American. The error which Englishmen make in this whole field of technical education is a failure to recognise the difference between the skilled workman and the professional engineer. She has been endeavouring to compete with the highly trained scientific experts of Germany and America by simply educating the hand, training artisans in the belief that she was making professional engineers. Not until England is dotted with large and flourishing schools like the Central Technical College of London, not until the English realise the necessity of training both the hand and the head, and not until she perceives the full value of high-grade engineering education will she be safe from the intrusion of German and American engineers who have had a thorough engineering training." This view from outside confirms that which can be seen when our educational structure is examined from within, and supplies a further reason for increased scientific training for leaders of industry.

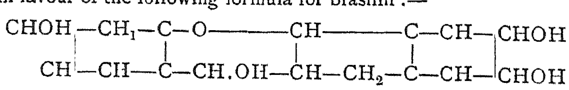
SOCIETIES AND ACADEMIES.

LONDON.

Chemical Society, December 19, 1901.—Prof. Emerson Reynolds, president, in the chair.—It was announced that the remaining meetings of the present session would be held alternately on Thursdays at 8 p.m. and Wednesdays at 5.30 p.m., commencing with an evening meeting on Thursday, January 16. The text of the address of congratulation to M. Berthelot was then read, and the secretary recorded the presentation of a plaster cast of the bronze portrait of Bunsen from the tomb at Heidelberg by Sir Henry Roscoe, and of a photograph of a bas-relief of Prof. Julius Thomsen by Mr. H. Faber.—The following papers were read:—(1) The constitution of corydaline, (2) the relations of corydaline to berberine, by Dr. J. J. Dobbie and Mr. A. Lauder. The authors have studied exhaustively the action of various oxidising agents, such as potassium permanganate and dilute nitric acid, upon corydaline, an alkaloid derived from the Tyrolean plant *Corydalis cava*, and by the identification of the ultimate oxidation products have established the fact that it is closely related to the yellow alkaloid berberine, and have therefore assigned to it a constitutional formula of the type suggested by Perkin for the latter alkaloid. The interrelations of the two alkaloids are shown in the following scheme:—

Corydaline (colourless) $C_{22}H_{27}NO_4$	by *oxidation* gives	dehydrocorydaline (yellow) $C_{22}H_{23}NO_4$.
Berberine (yellow) $C_{20}H_{17}NO_4$	by *reduction* gives	tetrahydroberberine (colourless) $C_{20}H_{21}NO_4$.

The constant difference C_2H_6 observed in the corresponding alkaloids of the scheme is accounted for by the presence of a methyl group in the α position of the pyridine ring and the occurrence of two contiguous methoxyls in place of the piperonyl group of the berberine formula of Perkin.—The magnetic rotation of some polyhydric alcohols, hexoses and disaccharoses, by Dr. W. H. Perkin, sen. The phenomena of varying specific rotation shown by solutions of sugars have been explained by the assumptions that these substances in the solid form possessed a structure which became modified gradually in their aqueous solutions, or that the solid was made up of complex molecules which underwent simplification in the presence of a solvent, or that solution was accompanied by gradual hydration. The magnetic rotations of solutions of the various sugars show that the first of these hypotheses is probably the correct one, and incidentally it was found that the observed values for dextrose agreed best with those calculated for Tollens' formula, which represents that substance as similarly constituted to ethylene oxide.—Stereoisomeric halogen derivatives of α-benzoylcamphor, by Dr. M. O. Forster and Miss F. M. G. Micklethwait. α'-Benzoyl-α-bromocamphor and α-benzoyl-α'-bromocamphor were prepared and characterised; the former has the specific rotation $-10°$ in benzene, the latter under the same conditions $-53°$. The corresponding chloro-derivatives have respectively the rotations $-27°$ and $+26°$ in chloroform.—Brasilin and hæmatoxylin, by Prof. W. H. Perkin, jun. These closely related substances are the characteristic colouring matters respectively of Brazil wood and logwood. As the result of a long-continued investigation in conjunction with his pupils, the author had suggested two formulæ which might equally well represent the constitution of hæmatoxylin, and the present paper gives conclusive evidence in favour of the following formula for brasilin:—



hæmatoxylin being hydroxybrasilin with the —OH in the position 1.—Is argon an elementary substance? by Mr. G. Martin. The view is put forward that since argon furnishes no characteristic series of compounds it may be regarded as a mixture of elementary gases.—The action of phosphorus trithiocyanate on alcohol, by Dr. A. E. Dixon. In this reaction thiocyanic acid is formed together with isopersulphocyanic acid, but no substance of the formula $C_8H_{18}N_4S_4O$, as found by Lössner, could be obtained.—The influence of salts and other substances on the vapour pressure of aqueous ammonia solutions, by Dr. E. P. Perman. Alkali salts produce an increase of pressure, while the formation of complex substances with copper salts reduces it.—The action of sodium hypochlorite on benzenesulphoanilide, by Dr. J. B. Cohen and Mr. J. T. Thompson. Benzenesulphonyl-p-chloranilide is the principal product of this reaction, and has been obtained in a pure state and characterised.—The relationship between the substitution and constitution of benzeneazo-α-naphthol, by Dr. J. T. Hewitt and Mr. S. J. M. Auld. This substance is regarded as an oxyazo-compound, since on acetylation and complete decomposition it furnishes aniline, but not acetanilide, and by reduction gives rise to a hydrazo-derivative. The monobrombenzeneazo-α-naphthol behaves similarly, the substitution occurring in the naphthol nucleus.

Geological Society, December 18, 1901.—Mr. J. J. H. Teall, V.P.R.S., president, in the chair.—Prof. H. G. Seeley drew attention to a skull of *Equus fossilis* from Keswick, exhibited by Mr. J. Postlethwaite, and said that it belonged to a species of horse, but the skull appeared to be broader and flatter in front of the orbits than in the *Equus caballus*; and it gave evidence on the upper surface of being an aged specimen, an inference which was supported by the palatal conditions. Mr. Postlethwaite said that the skull was found beneath the floor of one of the rooms of a farm-house about six miles east of Keswick. The house, which is of considerable age, was being altered and repaired, and it was in taking up one of the floors, for the purpose of relaying, that the skull was found. The surface-deposit on the farm is Glacial Drift.—Prof. W. W. Watts called attention to the exhibited set of twenty-two photographs, the first of three sets to be published as typical examples of geological photographs by the committee of the British Association on geological photographs.—Coal and petroleum-deposits in European Turkey, by Lieut.-Colonel Thomas English. In this paper an account is given of the formations which include some recently discovered coal-seams and naphtha-bearing sands of Tertiary age in the little visited stretch of country lying to the north of the Gulf of Xeros in the Mediterranean, and of the western portion of the Sea of Marmora.—On the geological and physical development of Dominica; with notes on Martinique, St. Lucia, St. Vincent and the Grenadines," by Prof. J. W. W. Spencer. These islands form a continuation of the volcanic chain extending from Gaudeloupe, though separated one from the other by embayments in the submarine plateau, reaching to depths of more than 6000 feet, within the line connecting the shores of the islands. These submarine valleys head in cirques, like the amphitheatres which occur on the slopes descending from high plateaux. From the ends of the cirques, valley-like channels can be traced landward on the submerged plateaux, or can be found to cross them in order to join like features on the other side. The cols between the opposite valleys vary in depth from about 2000 to 3600 feet, except that between the Grenadines and the Trinidad banks, where the divide may not be more than 750 feet below the surface of the sea, and one south of St. Vincent (less than 1300 feet). Some of the submarine channels have remarkable tributaries. The drowned valleys, like those about the islands to the north, assume two very different forms—those with broad undulating outlines, such as characterise the features produced during the long Miocene-Pliocene period of erosion, when the surfaces of the land were at or near the base-level of erosion, and other types where very deep valleys and gorges incise the more rounded features of the drowned plateau, which in the early Pleistocene epoch thus appears to have stood for a limited time at an altitude of 6000 or 7000 feet, as shown within the limits of the Antillean mass (and still higher from evidence beyond). There are no coastal plains, strictly speaking; only to a very limited extent are the islands surrounded by shelves submerged to a depth of less than 200 feet. But the Grenadine banks are extensive. One or two outlying remnants of the Antillean plateau occur south-east of Dominica, and another about sixty miles east of Martinique, all of which may be fragments of the old coastal plains. All the islands are underlaid by old Tertiary or pre-Tertiary igneous rocks—On the geological and physical development of Barbados, with notes on Trinidad, by Prof. J. W. W. Spencer. Barbados, more than 100 miles east of the main chain of islands, is a remnant of the dismembered and sunken Antillean plateau, with the embayment in it, west of the island, reaching to a depth of more than 7000 feet. But the drowned Barbados ridge extends far, both to the south and to the north of the island, and is connected by another ridge with the Martinique mass. Trinidad is part of the South American continent, being on the subcoastal shelf which extends much

farther seaward. Trinidad has more continental features than the other islands. Its surface-topography has been found to owe its origin to the erosion features of the Miocene-Pliocene period, which have been covered by only thin mantles as in Barbados, so that its life-history falls into harmony with that of the other islands. In its older beds it has the deep oceanic oozes as in Barbados. No volcanic phenomena have been added to the features of these islands.

Royal Microscopical Society, December 18, 1901.—Mr. William Carruthers, F.R.S., president, in the chair.—Messrs. R. and J. Beck exhibited a new micrometer microscope, the body of which was made to traverse across a long stage by means of a fine screw, the milled head of which was divided so as to indicate a movement of 1/100 millimetre. The body could also be placed in a horizontal position, when it could be used as a telescope to measure distant objects.—Mr. F. W. Watson Baker exhibited a number of microscopic specimens illustrating the development and structure of eyes. They were shown under twenty microscopes and were the most perfect sections which could be obtained from the best preparers in this country and abroad.—Mr. Nelson sent three notes which in his absence were read by the secretary. The first was a description of Holtzapffel's microscope. The date of it is 1830 and in it are found four original devices, (1) the clamp foot for clamping the instrument to the edge of a table, predating a similar device of Varley's in 1831; (2) the back of the mirror is flat polished brass so that monochromatic light may be reflected by it; (3) the stage is focussed by an excentric which differs from and predates the somewhat analogous devices of Pacini and Plössl; (4) the movement of the lens holder by means of a steel tape and pinion. The second note was a description of the first English achromatic objective, made by W. Tulley. It was a triplet and was made at the suggestion of Dr. C. R. Goring, who paid 90*l*. for it. The focus of the combination is 0·933 inch, initial magnifying power 10·72, N.A. ·259, and the O.I. the large amount of 24·2. Mr. Nelson then described the Chevalier-Euler achromatic objectives of 1823–24 and 1824–25. These were doublets, and in 1827 Mr. J. J. Lister put one of the Chevalier doublets as a front and a Tulley's triplet as a back lens. The focus of the combination was 0·52 inch and it was the finest microscopic objective that had up to that time been produced, and was, strictly speaking, the first really successful scientific microscopic objective. Lister's labours in perfecting objectives and the great use they had been to the leading opticians of the day were referred to. The third note was on a useful caliper gauge. It can be purchased at any watchmaker's tool shop for three or four shillings. It is convenient for measuring the thickness of cover glasses, and for low-power work the scale may be placed on the stage of a microscope and the constant of an eye-piece micrometer found by comparison with the mm. divisions.—The president gave an account of some investigations which he had made in reference to a disease that had caused great mischief in the cherry orchards in Kent. About fourteen months ago, when his attention was first directed to it, the disease was prevalent over a considerable area, a noticeable feature in connection with it being the persistence in the autumn of the dead leaves on the branches, instead of their falling off, as they would if the trees were healthy. The leaves of affected trees were pervaded by the mycelium of a fungus which destroyed them, and as the food of the tree was prepared by the leaves, the growth of the tree would, as a consequence, be arrested. The results of experiments in the cultivation of the fungus showed it to be one which belonged to the genus Gnomonia. Many of the fungi in this class passed through various stages in their life-history, for example, the mildew on wheat, which was first developed on the berberry and then spread to the wheat, appearing first as rust and afterwards as mildew from the same mycelium. The president referred to the absence in this country of any authority competent to investigate cases such as this; on the continent, however, the Governments had taken up the matter, and the experts who had inquired into it had found that to check the spread of the disease it was necessary to collect all the dead leaves and burn them. The president had consequently urged upon the fruit growers the necessity of following this recommendation, but had only been able to persuade two growers to do so; both of these, however, had found it to be thoroughly effective. Prof. A. W. Bennett in his remarks enlarged upon the absence in this country of investigations into such matters by State-paid establishments, and described what was being done in the United States, where every State had its own experimental station.

PARIS.

Acadamy of Sciences, December 30, 1901.—M. Fouqué in the chair.—M. Albert Gaudry was elected vice-president for the year 1902.—On double fertilisation in the Solanaceæ and Gentianaceæ, by M. L. Guignard. A study of *Nicotiana tabacum* and *Datura loevis* in the Solanaceæ and of *Gentiana ciliata* shows that double fertilisation is effected in both of these orders in essentially the same manner as in other cases which have been observed.—On a series of factorials, by M. Niels Nielson.—On linear differential equations which are of the same species, by M. Alfred Lœwy.—Some new theorems on entire functions, by M. Ernst Lindelöf.—On integral invariants and differential parameters, by M. Alf. Guldberg.—Internal tensions produced by two equal directly opposed forces acting on an indefinite solid, by M. Mesnager.—The critical constants and molecular complexity of some hydrocarbons, by MM. Ph. A. Guye and Ed. Mallet. The critical pressures and temperatures are given for durene, naphthalene, diphenylmethane and diphenyl. From these are calculated the critical coefficients, the constants a and b in Van der Waals' formula and the ratios of the real critical density to the theoretical. The conclusion is drawn that none of the hydrocarbons studied are associated at the critical point.—The extension of Kirchhoff's laws, by M. E. Carvallo. The results of this investigation are expressed as follows: The flux of the total current through the whole of a closed surface is zero, and the total electromotive force which rules in a closed circuit is zero.—On a new reaction between electrostatic tubes and insulators, by M. W. de Nicolaiève.—The action of high-frequency currents upon animals, by MM. H. Bordier and Lecomte. It has been shown that high-frequency currents can be applied directly to man without any sensation being produced, in spite of the large amount of energy which can be thus transmitted. It has been suggested as an explanation of the absence of sensation that the currents pass over the surface of the body without penetrating it. The experiments of the author negative this view, as such currents were found to be fatal to the rabbit, guinea-pig and rat.—Remarks on the preceding communication, by M. d'Arsonval. The facts described by MM. Bordier and Lecomte are in full accord with previous observations of the author. Stress is laid upon the conditions which must be observed in studying high-frequency currents. It is necessary to avoid all action on the sensibility, muscular contraction, and all abnormal elevation of temperature.—On the existence of rays capable of reflection in the radiation emitted by a mixture of the chlorides of radium and barium, by M. Th. Tommasina.—On the electro-capillary maxima of some organic compounds, by M. Gouy.—The heat of formation of the hydrate of chlorine, by M. de Forcrand. The number deduced from the dissociation curves of Isambert, Roozeboom and Le Chatelier is 18·16 calories; the value obtained from direct experiment is 18·57.—On the determining causes of the formation of the visual organs, by M. Antoine Pizon. The phenomenon of vision is regarded simply as a consequence of the accumulation of pigmentary granules at certain points of the body, and of the absorbing power of these granules for light rays. These views are regarded as affording an explanation of the occurrence of the eyes in the regions of greatest illumination, the position of the cephalic eyes, the extraordinary number of eyes in certain annelids, the more or less complete disappearance of the eyes in species inhabiting caves and in internal parasites.—The leaf trace in ferns, by MM. C. E. Bertrand and F. Cornaille.—On the eclogites of the Aiguilles Rouges, by M. Étienne Joukowsky.—On ergot of rye, by M. Marcel Guédras. The therapeutic action of this drug is due to sphacelinic acid and to cornutine. These active principles cannot be separated practically, since they have nearly the same solubility.

NEW SOUTH WALES.

Linnean Society, November 27, 1901.—Prof. J. T. Wilson in the chair.—The following papers were read:—Descriptions of new genera and species of Australian Lepidoptera, by Mr. Oswald B. Lower. Sixty-seven species referable to six families, namely, Arctiadæ 2, Noctuidæ 39, Thyrididæ 1, Pyralidæ 23, Tortricidæ 1, Plutellidæ 1.—The deterioration of raw and refined sugar crystals in bulk, by Mr. R. Greig Smith. The deterioration of bulk crystals is in many cases caused by *Bac. levaniformans*,

which was separated from many samples of inverting sugar. The conditions necessary for the degradation are a moist state of the sugar and a warm temperature. The formation of gum levan is in abeyance, probably on account of the infinitesimal amount of nitrogenous food. The bacillus is widely distributed, having been found in beet crystals from France and Germany and in cane sugar from Java, Egypt and Australia.—The acid fermentation of raw sugar crystals, by Mr. R. Greig Smith. *Bac. levaniformans* may set up an acid fermentation whereupon the sugar smells strongly of acetic and butyric acids.—Notes on the botany of the interior of New South Wales, part v., by Mr. R. H. Cambage. The conspicuous vegetation of the country around the Lachlan River, extending from Parkes to Marsden, is dealt with.—Studies in Australian entomology, No. xi. Description of a new ground-beetle from Victoria, by Mr. Thomas G. Sloane. The insect here described is a species of Morphnos, easily distinguished from the only other member of the genus, *M. flindersi*.—On the skeleton of the snout and os caruncula of the mammary fœtus of monotremes, by Prof. J. T. Wilson.—The protoconchs of some Port Jackson gasteropods, by Mr. H. Leighton Kesteven.—Studies on Australian Mollusca, part v., by Mr. C. Hedley. Several land shells hitherto unfigured, collected by the Chevert Expedition, are herein illustrated.

ST. LOUIS.

Academy of Science, December 2, 1901.—Mr. J. Arthur Harris presented in abstract a paper on normal and teratological thorns of *Gleditschia triacanthos*, L.—Prof. A. S. Chessin, of Washington University, delivered an address on the harmony of tone and colour. The speaker said that although the idea is not new that colours, like tones, are subject to laws of harmony, he did not know that any systematic theory concerning this had thus far been presented, and the object of the paper was to establish such a theory. A colour-scale was constructed, and the properties of the intervals corresponding to those appearing in the musical scale were discussed, and the conclusion was reached that within the limit of an octave the laws of harmony in tone and colour are identical.—A paper by Prof. A. S. Chessin, on the true potential of the force of gravity, was presented and read by title, the author remarking that this was the first of a series of detailed papers bearing upon the general subject, the broad conclusions concerning which he had presented in synopsis at a recent meeting of the Academy.

DIARY OF SOCIETIES.

THURSDAY, JANUARY 9.

MATHEMATICAL SOCIETY, at 5.30.—Non-uniform Convergence, and the Integration of Series: the President.—Network: S. Roberts, F.R.S.—On Quartic Curves with a Triple Point: A. B. Basset, F.R.S.—On the Integrals of the Differential Equation

$$\frac{du}{\sqrt{f(u)}}+\frac{dv}{\sqrt{f(v)}}=0,$$

where $f(x)\equiv ax^4+4bx^3+6cx^2+4dx+e$, Considered Geometrically: Prof. W. Snow Burnside.—On the Fundamental Theorem of Differential Equations: W. H. Young.

INSTITUTION OF ELECTRICAL ENGINEERS, at 8.—Discussion of the Technical Reports on the Institution Visit to Germany, 1901, by the Committees on Traction, Light and Power; Manufacturing, and Telegraphs and Telephones.

FRIDAY, JANUARY 10.

ROYAL ASTRONOMICAL SOCIETY, at 5.—The Attraction of the Himalaya Mountains upon the Plumb-line in India: Major S. G. Burrard.—The Period and Light Curve of the Variable Star 6685 Y Lyræ: A. Stanley Williams.—Note on a Further Attempt to observe the Corona without an Eclipse: Rev. C. D. P. Davies.—The Double Star Σ 1639 Comæ Berenicis: Thomas Lewis.

MALACOLOGICAL SOCIETY, at 8.

MONDAY, JANUARY 13.

SOCIETY OF ARTS, at 8.—The Purification and Sterilisation of Water: Dr. Samuel Rideal.

ROYAL GEOGRAPHICAL SOCIETY, at 8.30.—From Shanghai to Bhamo: Dr. R. Logan Jack.

TUESDAY, JANUARY 14.

ROYAL INSTITUTION, at 3.—The Cell: Prof. A. Macfadyen.

ZOOLOGICAL SOCIETY, at 8.30.—Observations on some Mimetic Insects and Spiders from Borneo and Singapore: R. Shelford.—On Variation in the Number and Arrangement of the Male Genital Apertures in *Nephrops norvegicus*: F. H. A. Marshall.—On some Remarkable Digestive Adaptations in Diprotodont Marsupials: Dr. Einar Lönnberg.

INSTITUTION OF CIVIL ENGINEERS, at 8.—American Workshop Methods in Steel Construction: H. B. Molesworth.

WEDNESDAY, JANUARY 15.

SOCIETY OF ARTS, at 8.—Elliptographs: Frank J. Gray.

ENTOMOLOGICAL SOCIETY, at 8.—Annual Meeting.

ROYAL METEOROLOGICAL SOCIETY, at 7.45.—Annual General Meeting.—Address on The Element of Chance in relation to various Meteorological Problems: W. H. Dines, President.

ROYAL MICROSCOPICAL SOCIETY, at 8.—Annual Meeting.—Address by the President.

GEOGRAPHICAL ASSOCIATION, at 3.—Annual Meeting.—Address on The Importance of Geography in Education: Right Hon. James Bryce, M.P.

THURSDAY, JANUARY 16.

LINNEAN SOCIETY, at 8.—On the Use of Linnean Specific Names: H. and J. Groves.—Exhibitions: Branches of Cherry affected by the Gnomonia Disease, with Remarks on its Effects and Climatic Causes: A. O. Walker.—Photographs and Specimens of Heads of Wild Sheep, to Illustrate a recent Suggestion as to the Use of Large Horns in Feral Species: J. E. Harting.

CHEMICAL SOCIETY, at 8.—Myricetin, Part II.: A. G. Perkin.—The Colouring Matters of Green Ebony: A. G. Perkin and S. H. C. Briggs.—An Investigation of the Radioactive Emanation produced by Thorium Compounds, I.: E. Rutherford and F. Soddy.

FRIDAY, JANUARY 17.

ROYAL INSTITUTION, at 9.—Interference of Sound: Lord Rayleigh.

INSTITUTION OF CIVIL ENGINEERS, at 8.—The Theory of Heat-Engines: Captain H. Riall Sankey.

INSTITUTION OF MECHANICAL ENGINEERS, at 8.—Modern Machine Methods: H. F. L. Orcutt.

EPIDEMIOLOGICAL SOCIETY, at 8.30.

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THURSDAY, JANUARY 16, 1902.

PSYCHOLOGY OF LANGUAGE.

Völkerpsychologie. By W. Wundt. Erster Band. Die Sprache. 2 Parts. Pp. xv+627 and x+644. (Leipzig: Engelmann, 1900.) Prices 14*s.* net and 15*s.* net.

PROF. WUNDT'S two bulky volumes form the first part of a long-expected treatise on race-psychology. The distinguished author has not the gift of concise utterance, and one almost shudders to think of the thousands of pages to which the work promises to extend by the time the second and third parts, dealing with myth and custom, have been completed. It is, perhaps, unfortunate that Prof. Wundt should have determined to treat his two remaining topics in the order just indicated; if there is anything at all in the results and methods of modern anthropology, it is from customs of the most practical kind, in fact from magic, that mythology on the whole derives its existence; hence one would think that custom rather than myth is entitled to the central position in a systematic "Völkerpsychologie." Can it be that Prof. Wundt's arrangement of his material has been unconsciously influenced by the now obsolete or obsolescent view of mythology as a "disease of language"? In any case, the intimate connection of the myths of one age with the magic of its predecessors seems to diminish the value of the author's psychological scheme by which custom is made to correspond to the volitional, myth to the emotional, aspect of racial life (vol. i. p. 27).

No one but a specialist in comparative philology is really competent to deal minutely with Prof. Wundt's elaborate investigations into the psychology of language. In the present notice, it is impossible to do more than supply a very brief summary of the topics treated of, and a briefer indication of a few of the author's leading results. He begins with a detailed and careful description of the general characteristics of emotion and its expression, which leads up to a study of the simplest and crudest form of language, the expression of emotion by a code of gestures. The account of gesture-language, which is based upon the artificial systems of signs in use among the dumb, as well as of the wide-spread gesture-language of the North-American Indians and of the Neapolitan populace, is full and interesting, especially in dealing with the question of the existence of grammatical form in gesture-speech. That gesture-language is not formless, as is often asserted, is well shown by reference to the fixed order in which the gesticulator expresses the constituent parts of a proposition. Prof. Wundt, by the way, appears not to be acquainted with the singularly full and excellent study of the gesture-language of Australian tribes contained in Mr. W. E. Roth's "Aborigines of North-West-Central Queensland." Proceeding in his third chapter to deal with articulate sounds, the author has much that is useful, if little that is new, to say about the differences between the song of birds and the song of men, and between the song and the speech of men. Incidentally he derives human song from vocal accompaniments of the rhythmical movements of work, and therefore regards its connection with religious cultus as secondary (i., p. 265). It might, perhaps, be objected that the beginnings of both rhythmical movement and its vocal accompaniments are to be found in the corroborees of the Australians, among whom systematic work hardly exists, and that here, at all events, the rhythmical movements appear to arise directly out of the magical representations of incipient cultus. Prof. Wundt is on surer ground when he goes on to deal with the origin of onomatopœia. It is impossible to resist the arguments by which he shows that direct and intentional imitation of natural sounds can have little to do with the origin of names, and that the real process is one of impulsive and unintentional imitation by the organs of articulation of striking forms of physical movement.

The fourth chapter deals with the psychological causes of sound-change. Prof. Wundt finds the principal source of regular and continuous changes affecting whole classes of sounds, apart from such incidental influences as those of climate or racial mixture, in the growing tendency of civilised men to speed of thought and utterance. To this psychical source he traces those changes in articulation which have often been ascribed to the imaginary desire for ease of utterance; a desire which, in the first place, is never consciously operative, and, in the second, could not exist unless advance in culture brought with it tendencies which make an originally easy articulation increasingly difficult. Such tendencies we have in the increasing speed of civilised speech, with its effects upon pitch and accent. Prof. Wundt uses his theory chiefly to explain the familiar changes formulated in "Grimm's law." On the value of the explanation no doubt the philologists will claim to be heard, but it has at any rate the merit of assigning a psychological *causa vera* for facts which have often been either left entirely unaccounted for or put down to a purely imaginary "desire for ease." In the case of the sound-changes produced by assimilation, a second psychological principle is invoked, viz. the tendency of thought to outrun speech. The assimilation takes place because the second sound is already "in consciousness" before the first has been duly articulated. The same principle in combination with the laws of association is in the succeeding chapter employed to explain the various forms of paralalia. Curiously enough, the author does not treat of the important vowel-changes which occur in the life of a language, such as those by which diphthongs have been substituted in modern spoken English for so many of the original vowels. In the chapter on word-formation the sections dealing directly with the nominal subject are rather of grammatical and philological than of strictly psychological interest. The earlier parts of the chapter, on the other hand, which treats of the cerebral speech-centres, the phenomena of aphasia and the perception of short words, are of great psychological interest, but so loosely connected with the ostensible subject of the chapter that they would be more in place in a separate work on experimental and physiological psychology.

Prof. Wundt's second volume is at once far the more important half of his book and the more difficult to describe with justice in a brief notice. He has set himself the gigantic task of digesting the facts contained in such works as F. Müller's monumental "Grundriss der Sprachwissenschaft" into a systematic form, and eliciting

from them a psychological theory of the successive evolution of grammatical form and syntactical construction. This task is performed in the two chapters which deal with "word-forms" and "sentence-construction." These are followed by a chapter on the psychical causes of change of signification, and the whole work concludes with a final chapter devoted to a brief *résumé* and criticism of the various theories of the "origin of language." It is significant of the influence exerted upon modern psychological thought by the concept of evolution that this last chapter is by far the shortest in the book and that its result is in the main the purely negative one that speech, like the other human faculties, has no definite beginning or origin, but is connected by a continuous development with a pre-articulate and pre-human past, while the earliest stages of language known to us themselves presuppose a long development within human speech itself. Of the elaborate investigations which fill Prof. Wundt's chapters vi.–viii. it is impossible, for reasons of space, to say much except that they are of the highest psychological interest and importance. Specially important are the distinction between a preeminently nominal and objective type of language, like those, *e.g.*, of the American or of the Ural-Altaic family, and a pre-eminently verbal and subjective type, like that to which we are accustomed in the familiar Indo-Germanic group, and the very similar distinction, in the realm of syntax, between the attributive and predicative types of proposition as corresponding to the "nominal" or objective and the "verbal" type of thought respectively. These and similar differences, obviously pointing to marked divergence of psychological endowment, are minutely and learnedly discussed by Prof. Wundt in a way which only makes one regret that his weakness for diffuse expression makes it so difficult to get a clear and systematic grasp of his argument as a whole.

A. E. T.

ELECTRICAL ENGINEERING TESTING.

Electrical Engineering Testing. By G. D. Aspinall Parr. Pp. viii+474; 218 diagrams, 31 tables. (London: Chapman and Hall, Ltd., 1902.) Price 9*s.* net.

DURING the last few years the rapidly spreading use of electrical methods of dealing with engineering problems has been naturally accompanied by the publication of a great mass of isolated work on the testing of electrical materials and machinery. Successful design requires not merely a knowledge of principles, but an intimate acquaintance with the properties of materials to be used; that these may be used economically and without needlessly high "factors of safety." And an electrical engineer is required to understand how to test for magnetic and electrical excellence the material he may have to use, as well as how to test his machinery for efficiency and staying power and his instruments for accuracy. It is probable that electrical engineering testing presents not only a possibility of, but a necessity for, greater refinement of measurement than occurs in other branches of engineering testing; the success of much of our electrical machinery and apparatus being more immediately dependent on exact design.

When a subject is developing so rapidly as that which Mr. Parr has chosen, it is not easy to maintain an exact knowledge even of what should be regarded as the simpler matters, and it is still less easy to keep this knowledge in due proportion. For that which was but lately abstruse or useless may rapidly become clear and even elementary information.

The volume before us will prove useful to many, containing, as it does, much information relating to electrical testing which, in spite of a rather unsatisfactory arrangement, is in a fairly accessible form. Its main portion consists of accounts of about 130 different tests, each arranged as follows:—A descriptive introduction; a list of apparatus wanted; what observations to take and how to take them; and concluding with "inferences" to be drawn from the results of the test. The book is styled "a practical work," meaning, we presume, not so much a text-book in which difficulties are explained as a hand-book containing useful information about tests. It is primarily written for students, and we do not doubt it will prove very useful alike to student and demonstrator.

The "descriptive introductions" are probably as satisfactory as the nature of the book will allow. The list of apparatus, while usually complete, will strike the reader as relating in particular to the apparatus of Mr. Parr's laboratory in the Yorkshire College. The next section of each test on taking and tabulating observations is very well given. It will save the student much thought and keep him from much bungling, and will raise the quality of his work—all but the first no doubt desirable when the course must be hurried over. The "inferences" are added at the end "to make the experimenter think and reason for himself." If the test had not been so well arranged for him beforehand, or the instructions so fully given, perhaps he would have had to think for himself before the test could have been carried out. This is a matter of opinion; but we think that the book will prove more useful in evening classes than with day students.

An appendix gives in a few pages the derivation of some formulæ employed, and the book concludes with some 100 interesting pages descriptive of apparatus used. The author shows much of his own apparatus and methods, which are interesting even when they do not strike one as the best.

The book is nicely printed, but bears signs of haste in preparation. Thus most readers, when they have grasped the peculiar use of the word "inference," will be surprised, if not amused, at the following: "Inference: Does the accuracy of the above test depend upon anything in particular?" p. 17; and on p. 22, under a similar heading, "Can anything in particular be deduced from the above results?" The author spells converter with an *o* in the final syllable, and writes anti-inductive where non-inductive is meant; and slips such as series for serious, p. 154, sale for scale, p. 378, Jolly for Joly, p. 390, &c., which are not infrequent, should have disappeared in the proof.

The figures are on the whole good, and the tables at the end welcome.

The author's style is often by no means lucid, and even when the meaning is clear it does not make agreeable

reading. The book is a great contrast to the other recent English work on the same subject, by Dr. Fleming, which is both readable and interesting. But we feel that there is a place also for a book such as Mr. Parr's, in which short accounts of many specific experiments are given, and the book will be of value to engineers as well as in a teaching laboratory.

D. K. M.

BURMA.

Burma under British Rule—and Before. By John Nisbet, D.Œ.C. Two volumes. Pp. xvii + 912. (Westminster: Archibald Constable and Co., Ltd., 1901.) Price 32*s*. net.

LITTLE more than a year ago a most beautifully illustrated, interesting volume on "Burma," by Max and Bertha Ferrars, appeared, which has been most favourably received. And now we have a second work on Burma. This comparatively recent part of the empire, then, receives a full share of attention, and not the least interesting part of the business is that both Mr. Ferrars and Dr. Nisbet are retired Burma forest officers. Even a cursory glance at the books will show that these two gentlemen have become most intimately acquainted with the customs and character of the Burmese. As a matter of fact, though this has not always been admitted, there is no branch of the Indian services the members of which come into closer contact with the inhabitants away from towns, than Indian forest officers. If it is remembered that in many cases the peoples in question live in out of the way places and that many of them never see a magistrate or a judge, it will readily be acceded that the selection and training of the members of the Indian forest service should be done with special care, since the happiness of millions of ignorant people depends to a considerable extent on the tact and sympathy of these officers.

Mr. Nisbet's work is divided into two volumes. In the opening chapter of vol. i. he deals with the history of Burma from the year 2266 B.C. to 1852 A.D. It will readily be understood that this sketch, occupying twenty-five pages, can only touch lightly on the history of this interesting country, and, unfortunately, the notes appear to us by no means as well arranged as they might be. Chapter ii. describes the political and commercial relations between British India and Upper Burma during the years 1853–80, relations which were anything but cordial. Here we find the great shoe question recorded, that is to say, that the British envoy had to take off his shoes and kneel down if he wished to address the King of Burma, until we come to the massacres of some fifty members of the Royal house by King Thibaw. The existing and increasing differences are further described in Chapter iii., explaining the causes of the third Burmese war. It broke out in November 1885, resulting in the annexation of Upper Burma. Apart from the utter unreasonableness of the last two kings of Burma and the cruelty of Thibaw, French intrigues contributed most powerfully to hurry on the crisis. The last straw, however, was the difference between King Thibaw and the Bombay-Burma Trading Corporation, the latter having been fined 153,000*l*. by the former. For ourselves, we cannot conceal that we should have been better pleased if the crisis had come without this last incident.

Chapter iv. deals with the third Burmese war, which practically lasted only from November 13, 1885, till January 1, 1886; but it was followed by five years during which the pacification of the country was ultimately effected.

Chapters vi.–viii. deal with civil and military administration, law and justice under Burmese rule, and the Royal Golden City. They contain much interesting information, of which the marriage law is perhaps the most curious. There were seven kinds of wives, of which four could not be divorced, but there was no difficulty in getting separated from any of the other three kinds.

Chapter ix. gives a rapid survey of "The British System of Administration in Burma." It shows how an orderly administration has been established in a comparatively short time as regards the organisation of the civil authorities, law, military and police, public works, forests, education and revenue. Of special interest is the development of the latter, it having risen from 2,415,000*l*. in 1886–87 to 5,242,000*l*. in 1899–1900, while the surplus has, during the same period, risen from 637,000*l*. to 1,821,000*l*. It is shown that Burma has already more than repaid all the outlay upon it during and since the third Burmese war. The net revenue includes a sum of 400,000*l*. derived from the teak and other forests, and this sum is capable of a further great increase.

Chapters x. to xiv. give a detailed account of the various branches of administration, such as the land tenure, settlements, agricultural and rural customs, minor rural industries (such as sifting for gold dust, silk weaving, dyes and dye-stuffs, pottery, fisheries, collection of wood-oil, preparing and transport of timber, cutch boiling, manufacture of cheroots, &c.); the mineral resources (coal, petroleum, tin, silver, lead, gold, jade, rubies); trade and commerce (the sea-borne trade of Burma in 1888–89 amounted to a value of 11,717,000*l*.; in 1899–1900 it had risen to 20,820,000*l*.)

The second volume opens with a chapter on Britain and France in further India and south-western China, and is followed by others on railway extensions; Burma's forest wealth and the importance of maintaining and increasing the production of teak timber; Burmese Buddhism; beliefs and superstitions; national habits and customs; the social system; national festivals and amusements; science and art among the Burmese; language and literature; folklore; archæology and the hill tribes.

It would be beyond the scope of this notice to go into the details of all these matters, but attention may be drawn to two points: As regards railways, Dr. Nisbet points out that the most pressing need is to develop internal communication before connections with the outside are established. When the time and money for the latter have become available it will be well, in the first instance, to connect Burma with India *via* Assam (or Arakan and Chittagong), then with Siam, leaving any possible connection with China, by way of Yunnan, for discussion in the future. Although we agree with this

view, it may happen that events in China will upset it, and that a connecting link between Burma and Yunnan by means of a railway may become a necessity.

The second point to which we desire to draw attention is the chapter on Burma's forest wealth. It is but natural that this is treated in a very full way, and we recommend its perusal to those who have up to date been hostile to forest conservancy in India and Burma. More especially Dr. Nisbet describes in full detail the great pains which are taken in ascertaining the full extent of existing rights and privileges, and the minuteness with which the requirements of the local population are provided, before any forest tract is declared a permanent State forest.

On the whole Dr. Nisbet's work may be called a very storehouse of information on Burma, to collect which must have taken him many years. If we were to find any faults with the work they would be that the author's facile pen has led him into too great a length, and that there are numerous repetitions in it. Still, those who have leisure to read the two handsome volumes will be richly rewarded for their trouble. They will find in it, not only a minute description of an interesting people, but also a record of the admirable manner in which civilised methods of administration have been successfully introduced in this far-away country in a remarkably short space of time.

OUR BOOK SHELF.

The Birds of South Africa. By A. C. Stark, completed by W. L. Sclater. Vol. ii. Illustrated. Pp. xiv+324. (London: Porter, 1901.) Price 21*s*. net.

IN a review of the first volume of this work (part of the "Fauna of South Africa"), published in our columns soon after its appearance, reference was made to the tragic death of its author, Dr. Stark, in Ladysmith, at the commencement of the siege. The first volume was practically completed by the author before his death; but of its successor the manuscript was left (partly stored at Durban and partly at Ladysmith) in a state which rendered necessary a considerable amount of revision and addition on the part of whoever undertook the task of editing and preparing it for press. By desire of Dr. Stark's executors this labour was entrusted to Mr. W. L. Sclater, the editor of the series to which the volume belongs, who is to be congratulated on having carried out so successfully an undertaking of no ordinary difficulty. For, as all those who have tried it are well aware, the completion of another man's unfinished work is often a more difficult task than to write a volume *de novo*. As this volume may be regarded as in some respects a memorial of the lamented author, his portrait is very appropriately introduced as a frontispiece.

Since the general plan of the work was somewhat fully referred to in our previous notice, and as in this respect the present volume agrees in all essential points with its predecessor, nothing need be added on the present occasion. This volume continues the description of the perching-birds, taking up the thread at the shrikes, and ending with the swallows and pittas, so that the African representatives of five families are discussed. The editor has been fortunate in again securing the services of Mr. H. Grönvold as artist; and, needless to say, the illustrations are exquisitely drawn, and at the same time true to nature. Attention may be especially directed to the figure of puff-birds and their nest, which is based on a photograph taken near Grahamstown, and forms a charming bit of bird-life. One illustration alone—that of rock-thrushes and their nest, on p. 182—has been reproduced direct from a photograph. A comparison of this with the above-mentioned picture by Mr. Grönvold leaves little doubt where the superiority lies. In addition to the text-figures this volume contains a map which should prove of much value to the students of the South African fauna.

While congratulating Mr. Sclater on the completion of this much of his arduous task, we may take the opportunity of mentioning that, with the help of Dr. Stark's note-books and papers he hopes ere long to bring out the two remaining volumes of the "Birds of South Africa." R. L.

Elementary Telephotography. By Ernest Marriage. Pp. xxix + 117. (London: Iliffe and Sons, Ltd., 1901.)

THE telephotographic lens is becoming more generally used every day, so that the publication of a good elementary treatise on the chief advantages of its employment and on its successful manipulation will be received with favour. The opening chapters describe, in simple and clear language, backed up with excellent illustrations, the optical arrangements of telephotographic lenses, the different types of such lenses, the work for which they are specially adapted, and the form of camera and accessories that experience has shown to be the most satisfactory. The author lays great stress on the importance of rigidity in both the camera and support, so the beginner should take special note of this fundamental consideration.

After a chapter on the general applications of telephotography, the author gives the beginner some excellent advice in separate chapters on the special branches of the subject, namely, architecture, portraiture and the telephotography of animals, illustrating the chief points with reproductions from photographs.

Last, but by no means least in importance, are two chapters on exposure and development and useful tables. In the former it is shown, among other things, that with a little trouble the most difficult part of the whole manipulation, namely, "correct exposure of the negative," may be successfully overcome by a simple calculation, this method being rendered more practicable and easy by the use of the tables given in the latter chapter.

It may be mentioned in conclusion that the book is neatly printed on good stout paper and the illustrations are well reproduced, so that with these extra points in its favour it will form a useful addition to photographic literature.

The British Journal Photographic Almanac, 1902. Edited by Thomas Bedding. Pp. 1560. (London: Henry Greenwood and Co., 1901.) Price 1*s*.

THE forty-first yearly issue of this almanac is well up to the standard of former years, and contains a mine of useful information for both the amateur and the professional photographer.

Among the principal contents we notice an interesting, and what should prove a useful, article on "Introductory Notes on Tele-photography," by the editor, which brings together the more important facts on the subject. This is followed by a series of short contributions on practical subjects by prominent photographers, by numerous notes and suggestions of the year, and by an epitome of the advances made in 1901. The almanac portion of the volume and tables will be found as useful as ever, and the reader will find the collection of photographic formulæ and recipes, list of photographic societies, and other miscellaneous tables and information very complete.

In addition to the 600 pages of text, those devoted

to advertisements have also their interesting features, and the numerous illustrations and process plates scattered here and there add an additional attraction to the volume. The success of this present edition will be gathered from the fact that it has already been sold right out, as is stated by the *British Journal of Photography*.

Encyclopédie Scientifique des Aide-Mémoire. Le Vin. Par Henri Astruc. Pp. 208. (Paris : Gauthier-Villars, 1901.) Price 3·0 F.

THIS little treatise on wine-making is essentially encyclopedic in character, and as such calls for only a brief notice. The author is evidently familiar with his subject, and in the limited space at his disposal has been very successful in reviewing both the scientific and economic position of the French wine industry. There is nothing novel in the scientific questions discussed in this book, but some of the economic questions brought forward are not generally recognised in this country. For instance, here we have been inclined to regard wine growing in France as only in process of recovery from the devastation wrought by phylloxera, and it comes as a surprise to be told by the author that the wine-growers of his country are at present suffering from the effects of over-production.

This little book will be useful to anyone who desires to make a rapid survey of the present position of the French wine industry. A. J. B.

A Commercial Geography of Foreign Nations. By F. C. Boon, B.A. Pp. viii + 174. (London: Methuen & Co). Price 2*s*.

THIS book will not assist to make commercial geography a scientific study. Like the geographical books of old time, the volume consists largely of disconnected details which no pupil ought to be asked to remember, and which produce weariness of the flesh in the unfortunate reader. If commercial geography means what Mr. Boon makes it, then it is the duty of all who are anxious for the introduction of reasonable methods of instruction in schools to condemn it at every opportunity. Here are a few examples of unqualified or loose statements which occur in the early pages of the book. "The greatest heat for the greatest number of days is on the Equator" (p. 1). "As the Equator is neared [from the Tropics] two days have vertical sunshine at each point within the Tropics, approaching gradually to the autumn and vernal equinoxes at the Equator" (p. 1). "Added to the effects of the neighbouring land or water are the similar effects of the winds that blow over them" (p. 2). "The Gulf Stream washes the coast of Norway" (p. 11). But we do not object so much to statements of this kind as to the principle of cramming pupils with information which has to be accepted without inquiry and cannot be assimilated. The less we have of commercial geography of this kind the more likely are we to create an interest in the study of the subject.

Mining Calculations. By T. A. O'Donahue. Pp. viii + 211. (London: Crosby Lockwood and Son, 1901.) Price 3*s*. 6*d*.

THE primary object of this little book is to enable candidates for certificates as colliery managers to obtain with a minimum of trouble a sufficient knowledge of arithmetic and mensuration to pass their statutory examinations. If the student will steadily work out the numerous useful examples given by the author, his chances of success will certainly be increased. Some of the absurdly easy arithmetical questions, quoted from the official examination papers, do not tend to enhance one's respect for the statutory certificate; however, this is no fault of the author, who has simply written a book to supply a want created by the examiners appointed under the Coal Mines Regulation Act.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

The Inheritance of Mental Characters.

ALL biologists must be grateful to Prof. Karl Pearson for his extremely valuable and interesting paper reported in your issue of December 5, 1901 (p. 118). Inasmuch, however, as his conclusions are likely to be taken as the settled results of scientific research, it may be appropriate at this time to express certain doubts which naturally arise on reading the abstract. A man at the age of thirty, for example, possesses certain physical, intellectual and moral qualities. These must be due to more than one class of factors, and may possibly be due to three:—

(1) Heredity; characters derived from ancestors, including for present purposes the results of normal variation.

(2) Environment.

(3) Soul; supposing that the man is something more than an intelligent mechanism, and considering the possibility that his soul may have preexisted his advent here as an individual of *Homo sapiens*.

The third factor will be ridiculed by many, but if it has any reality it may eventually be capable of demonstration by just such methods as Prof. Pearson employs. The first and second factors are universally recognised.

Now it is apparent at once that the influence of the several factors is not the same on all the qualities of the man. Stature will depend almost wholly on the first set of factors, eye-colour wholly so. On the other hand, health will certainly depend largely on the second, so will shyness, intelligence, &c.

If, therefore, it is found that stature and eye-colour exhibit exactly (or almost exactly) the same degree of divergence from parental or fraternal standards as do health, shyness, &c., may it not be that this disproves just what it seems to prove, because A does not equal B, but equals $B+x$?

It may be said that the statistics given are based on pairs of brothers, whose environment must have been almost identical, and hence the second factor would not affect the divergence between them. But this appears a doubtful argument, because (1) the treatment of successive children is very commonly not the same, and the fact of being an elder child is itself influential; (2) germinal selection must be supposed to be going on from the earliest moment of existence, and very slight environmental factors may make great ultimate differences.

There is another consideration, that of the stability of the different qualities in the race. Characters which were highly variable would not appear to be inherited to the same degree as those which were very stable. This might also appear in cases of atavism, where the pendulum of variability took an exceptionally long swing, going back to ancestral features of which we possessed no record. Thus let the inheritance be expressed by A B C D E A B C D E A B, &c., instead of A B A B A B, &c. In the former case our data might only cover A B C D, in the latter A B A B. We should say that the individuals of the latter series came very "true," those of the former not at all, though the result in the long run might be about the same in either case. Lest it be said that the former series is wholly imaginary, I will cite the case of the domestic dog. The ordinary mongrel street-dogs in a single town would afford material for several genera and very numerous species, judging them by the physical standards we employ for wild animals. Yet the domestic dog, taken as a whole, has not changed very much in long periods. That is to say, the extraordinary variability presented is not progressive under existing conditions, and we return sooner or later to about the starting point. T. D. A. COCKERELL.

East Las Vegas, New Mexico, U.S.A., December 20, 1901.

I AM not unmindful of the possible influence of environment in increasing the correlation of brothers. I strongly suspect that home influences have a good deal to do with the rather exaggerated value for the fraternal correlation in the category of *conscientiousness*. But certain characters, *e.g.* the cephalic index after three years of age, the eye-colour between twenty and thirty

and the hair-colour from seven to fourteen are but little, in England at any rate, subject to environmental influence. The cephalic index remains almost constant throughout life. Now the mean value for the fraternal correlation for these three characters is 0·5161, and for stature, span, forearm and health, which might be supposed to be largely influenced by environment, it is 0·5179. It thus seemed to me that environment was not an important factor in modifying the correlation of the *physical* characters between brothers. In other words, *environment does not influence the constant uniformly in one direction*. This view was apparently appreciated by Prof. Cockerell when he wrote "the treatment of successive children is not the same." Any influence of environment, strange as it may seem, was thus found to be negligible. Turning to the intellectual characters, my own *a priori* conception was that I should for the first time be able to distinguish between nurture and heredity. I expected much higher correlations in the case of temperament and probity than in that of physique. I was therefore somewhat surprised when the values came out much the same as in the case of the physical characters, say an average of 0·5. Of course it is open to Prof. Cockerell to say that 0·3 of this only is due to heredity and 0·2 to environment, or whatever other division appears to him probable, but he will then have to explain why the sum of the two makes 0·5, and why the influence of heredity is less in the intellectual than it appears to be for the physical characters. There is the obvious direct scientific interpretation which seems to me the true one, environment does not act in one direction in *either* case, and the mental and physical characters are inherited precisely at the same rate. To those who have taken the trouble, as I have done, to examine carefully the mental characteristics of a family at intervals of a century apart, so that we are not troubled by the co-environment peculiar to brothers, it is needless, perhaps, to urge the very strong inheritance of mental qualities. If Prof. Cockerell attributes it to his third factor, "pre-existing soul," I should, indeed, be proud to have aided in the demonstration of its reality, although I fail entirely to see how it is to be done "by just such methods as Prof. Pearson employs." Meanwhile most people will, I think, prefer to stick to heredity.

Of the last paragraph of Prof. Cockerell's letter I understand not a word. Correlation is quite independent of variation, and although skull capacity is highly variable as compared with length of femur, I see no reason for supposing the former is therefore less strongly inherited than the latter.

I have not touched on the influence of "local races" on my data, because that appears to be a factor which has escaped Prof. Cockerell, and so I am not bound to state a doubt which I have well considered in order to reject it.

KARL PEARSON.

Magnetostriction of some Ferromagnetic Substances.

WE avail ourselves of your valuable Journal to give a short notice of some new results, obtained in our researches on magnetostriction, being a continuation of our investigation on the same subject, given in the "Rapports présentés au Congrès international de Physique," t. ii., by one of us.

It was generally believed that ferromagnetic bodies show change of length by magnetisation, but not of volume. Minute as the effect generally is, it is now placed beyond dispute that iron, nickel, cobalt and especially steel differ also in bulk in the magnetised state from that in the unmagnetised. In the course of our researches on the magnetostriction of different ferromagnetic bodies in the form of ovoids we came across a substance which shows a remarkably large increase of volume.

Examining the magnetostriction of reversible nickel-steels of different composition, which were kindly placed at our disposal by Dr. Guillaume and M. Dumas, we find that alloys containing 46 per cent., 36 per cent. and 29 per cent. of nickel all show increase of length several times greater than that observed in ordinary iron. But far more striking is the change of volume; of the three above-mentioned alloys, the effect increases as the percentage of nickel becomes less; with 29 per cent. alloy we observed a motion of 5 mm. of the liquid in the capillary tube (diam. 0·4 mm.) attached to the volumenometer containing the specimen (volume $v = 10$ c.cm.) under examination. Thus the greatest change of volume by magnetisation amounts to $\delta v/v = 51{\cdot}1 \times 10^{-6}$ in $H = 1690$ C.G.S. With ordinary iron, the same change $\delta v/v = 1{\cdot}2 \times 10^{-6}$ in the same field, being only about 1/40th of that observed in nickel-steel. The magnetisation of 25 per cent. nickel alloy is so feeble that it is impossible for it to be magnetometrically measured, and the change of length is inappreciably small, but the volume change is measurable and amounts to $0{\cdot}2 \times 10^{-6}$ in $H = 1790$. It is thus quite probable that there is an alloy containing somewhat more or less than 29 per cent. of nickel that indicates largest increase of volume by magnetisation.

We at first thought it would be possible to trace some connection between the thermal expansion and the change of length by magnetisation. No such relation seems to exist; the 36 per cent. alloy, which is the least expansible by heat, indicates tolerably large elongation by magnetisation.

As regards the Wiedemann effect, nickel-steels behave very much like iron, showing the maximum amount of torsion in moderate fields.

As is well known, the behaviour of cast cobalt, as regards the change of length by magnetisation, is opposite to that of iron, but the volume change in the same metal is much smaller. By annealing cobalt in a charcoal fire it assumes a pale ashy colour, and the magnetic character is greatly changed. The metal becomes less magnetisable, and shows constant decrease of length accompanied by increase of volume.

We have also found, by actual experiment, that the effect of stress on magnetisation and the magnetostriction in cobalt and in nickel-steel are reciprocally related to one another, as was already established for iron and nickel.

H. NAGASKA,
K. HONDA.

Physical Laboratory, Imperial University,
Tokyo, December 3, 1901.

Results of International Magnetic Observations made during the Total Solar Eclipse of May 17–18, 1901.[1]

To test further the results obtained by the United States Coast and Geodetic Survey magnetic parties during the total solar eclipse of May 28, 1900, regarding a slight magnetic effect that may be attributable directly to some change produced in the electrification of the upper atmospheric strata by the abstraction of the sun's rays due to the interposition of the moon between the sun and the earth, an appeal was made for international cooperation in magnetic and allied observations during the recent total solar eclipse.

The repetition of the observations was doubly interesting owing to the fact that the present eclipse occurred in the opposite magnetic hemisphere to that of the year 1900, and hence the opportunity was afforded for ascertaining whether the magnetic effect was reversed in its general character to that of 1900, as is, for example, the case with the diurnal variation in passing from one magnetic hemisphere to the other. The conditions, however, for obtaining observations at a number of stations distributed along the belt of totality, as was done in 1900, and thus testing whether the magnetic effect again followed directly in the wake of the shadow cone, were not favourable owing to the present location of the belt of totality.

In response to the appeal, simultaneous magnetic observations were made on May 17 from 14 to 21 o'clock Greenwich mean astronomical time—an interval amply covering the time of the eclipse—at a number of stations encircling the entire globe, three of which were in the belt of totality. The prime purpose of making the observations so as to cover the entire globe was to furnish the possibility of separating a possible eclipse magnetic effect from a contemporaneous magnetic storm of the usual type. The eclipse effect, for instance, doubtless would be confined to a very small belt, whereas a customary magnetic storm, in conformity with the usual experience, would manifest itself at practically the same moment of time over a very large area and thus be felt at stations far from the totality belt.

At none of the outside stations has a disturbance of any appreciable size been thus far reported to me, the general consensus of opinion of observers at these stations being that "nothing unusual occurred."

At the three stations within the belt of totality the majority of opinion is that something unusual did occur during the time of the eclipse.

[1] Presented before the meeting of the Astronomical and Astrophysical Society at Washington, December 30, 1901.

Thus at Karang Sago, where was situated the Dutch eclipse party, Dr. W. van Bemmelen, assistant director of the Batavia Magnetic Observatory, observed the changes in the magnetic declination and in horizontal intensity, and he reports the occurrence of "an extremely interesting magnetic effect." He has courteously sent me an extract of his observations, made during several days before and on the day of the eclipse, and there certainly appears evidence of a magnetic effect in both elements different from that observed on the days prior to the eclipse.

At Sawah Loento, the site of the Massachusetts Institute of Technology party of Boston, the variations in magnetic declination were observed by Mr. G. L. Hosmer on May 17 and 18. Comparing the two days' results for the interval of the eclipse, there is indisputable proof that something different occurred on the day of the eclipse than on the day before. Namely, at this station, situated so close to the magnetic equator, the range of the diurnal variation of the magnetic declination is about one minute of arc. The magnetic effect during the time of the eclipse was of about the same amount, so that a steady *decrease* of east declination resulted during the time of day when, normally, there is a steady *increase*.

There was but one magnetic observatory directly within the belt, viz. the one at Mauritius, and this was situated not far from the place of beginning of the eclipse. No special magnetic observations were made at this place, however, but regular photographic curves giving the variations in the magnetic elements were obtained. The declination and the vertical intensity curves apparently do not show any disturbance that could easily be picked out and referred to the eclipse. Regarding the horizontal intensity curve—the more sensitive one—Mr. Claxton states "that the original curve shows slight tremors between 7.15 and 7.50, and occasionally between 8.5 and 9.0 a.m." I have plotted this intensity curve on a larger scale, and find that the curve shows no very marked disturbance that might be readily referred to the eclipse, with the exception of one producing an easily perceptible bulge in the curve amounting to about 3–4 units in the fifth decimal C.G.S. units and lasting about 30 minutes. Anyway the effect, if there be one, is very minute, and will not be so readily separated from the usual diurnal variation as in the case of the two previous stations. Whether this is due to the fact that owing to the vicinity of Mauritius to the beginning of the eclipse the minute eclipse magnetic storm did not have time to develop itself or was just in the embryonic state cannot be said.

The magnetic effect observed at Karang Sago and at Sawah Loento does not appear to have extended very far outside the belt of totality, it being scarcely appreciable at the Batavia magnetic observatory.

My grateful and appreciative acknowledgments are due to all who have participated in this interesting investigation—one, to my mind, of fundamental importance to the theory of the diurnal variation of the earth's magnetism as elaborated by Schuster and von Bezold. L. A. BAUER.

U.S. Coast and Geodetic Survey, Washington, D.C.
December 30, 1901.

The Roots of the Equation $u = \tan u$.

IN many treatises on optics it is stated that the roots of the equation, $u = \tan u$, were calculated by Schwerd. Verdet ("Oeuvres," t. v. p. 266), says :—"These roots have been calculated by Schwerd, who arrived at the following values : $u_1/\pi = 1{\cdot}4303$, $u_2/\pi = 2{\cdot}4590$, . . . " up to u_7/π. Preston ("Light," p. 255, second edition) says :—"The values of u corresponding to the maximum values of the illumination have been given by Schwerd as follows :—" The values given are precisely the same as Verdet's. Rayleigh ("Encyc. Brit.," vol. xxiv. p. 430, art., Wave Theory) gives a method for calculating the roots of the equation, and remarks that they were obtained in another manner by Schwerd. (There is a misprint in Rayleigh's value for u_4). Other references might be added.

Will someone kindly indicate where Schwerd gives the results referred to?

In his "Beugungserscheinungen" he shows that the roots of the equation are approximately the values of $(2n+1)\pi/2$, obtained by giving integral values to n; and he remarks (in § 63, p. 28) that for values $n=1$, and $n=2$, the true values of u differ by $12^\circ{\cdot}5$ and $7^\circ{\cdot}5$ from $3\pi/2$ and $5\pi/2$, respectively. In table i., at the end of the book, he gives values of the expression for the intensity, $\sin^2 u/u^2$, for values of u increasing by 15°; and at the foot of the table he states that the first and second maxima are at $257^\circ{\cdot}5$ (*i.e.* $270^\circ - 12^\circ{\cdot}5$) and $442^\circ{\cdot}5$ (*i.e.* $450^\circ - 7^\circ{\cdot}5$). Further details I have not found.

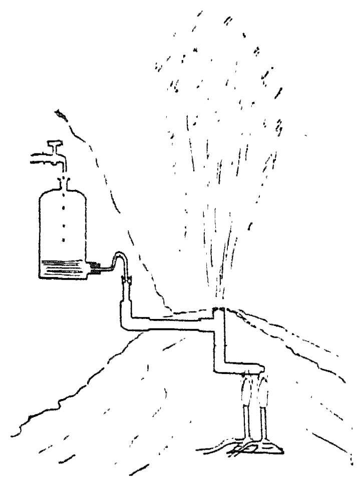
It may be remarked that the roots of the equation under consideration were given long before Schwerd's time. In Euler's "Introductio in Analysin Infinitorum" (Lausanne 1748) the question is fully discussed. See t. ii., cap. xx., prob. ix.

C. A. CHANT.

University of Toronto, December 27, 1901.

A Model Geyser.

IF the following working model, which was the outcome of a good many trials, is in any way original it may prove of interest, as it works automatically and with excellent effect as a geyser of regular period, suitable for a lecture table. The figure needs but little description. A small aspirator with a bent glass tube exit acts as an intermittent syphon. The water is discharged into a half-inch iron pipe, the long horizontal limb of which measures some 13 centimetres. The glass syphon tube slips through a rubber ring at the top of the pipe (gauge fitting), or a cork would doubtless answer the purpose. The lower closed end of the tube is heated by the equivalent of about four ordinary Bunsen burners, and should be placed as shown, as if placed



under the exit, steam is generated too fast and the water may be blown back into the aspirator. Water drips into the aspirator at such a rate that the syphon discharges about 300 c.c. of water once in every ten minutes. A jet of steam some six feet high and water some two feet high results, with many appropriate gurglings. The diameter of the exit is about 6 millimetres. Of course the apparatus is concealed; a large circular tin canister to which the iron pipe is screwed forms a good foundation and serves to keep the water off the burners. Furnace clinker, which is not wholly unsuitable, forms a readily obtainable material for completing the external features of the geyser.

Felsted, January. A. E. MUNBY.

Birds Capturing Butterflies in Flight.

WITH reference to Mr. Latter's letter in NATURE of November 16, 1899 (vol. lxi. p. 55), which has been brought to my notice, I would say that the supposition that birds do not attack butterflies in flight is not strictly correct.

The common King Crow (*Dicrurus ater*, I believe) invariably captures butterflies on the wing; I have seen these birds scores of times do this. Their usual prey seems to be a small deep yellow butterfly with black on the tip of the wings, but I have occasionally seen other butterflies so captured by them.

India, December 18, 1901. A. E. MCKAY.

THE FARMERS' YEARS.

I.

SOME years ago in the "Dawn of Astronomy" I showed how carefully the sun had been observed by the ancient Egyptians, not only when it rose or set at points most to the north or south, as at the solstices, but also when it rose exactly half-way between these points, that is, east and west at the equinoxes.

This fundamental division of the sun's apparent revolution and course which define our year into four

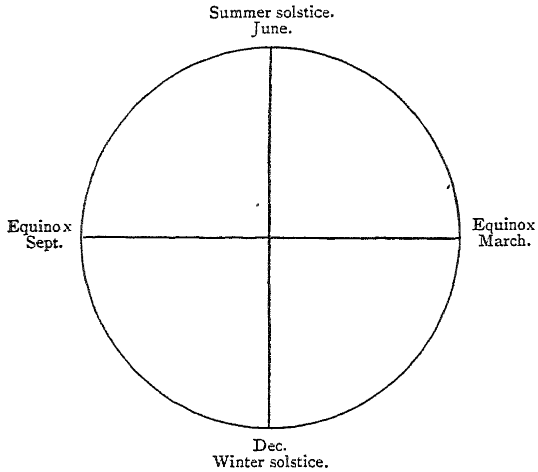


FIG. 1.

nearly equal parts may be indicated as in Fig. 1, the highest point reached by the sun in our northern hemisphere being represented at the top.

In order better to consider the problem as it was presented to the early astronomers who built observatories (temples) to mark these points, we may deal with the bearings of the points occupied by the sun on the horizon (either at rising or setting) at the times indicated.

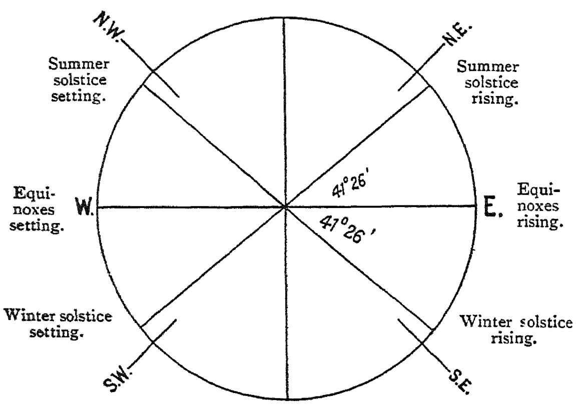


FIG. 2.—The various bearings of the sun risings and settings in a place with a N. latitude of 51°.

These points are conveniently defined by their "amplitude" or their distance in degrees from the E. or W. points of the horizon. In the diagram (Fig. 2) I represent the conditions of our chief British sun-temple, Stonehenge, in latitude 51° N. approximately.

Taking the astronomical facts regarding the solstices and equinoxes for the first year (1901) of the present century, we find:—

Sun enters	Aries,	Spring equinox,	March 21.
,, ,,	Gemini,	Summer solstice,	June 21.
,, ,,	Libra,	Autumn equinox,	September 23.
,, ,,	Sagittarius,	Winter solstice,	December 23.

These points, then, are approximately ninety-one days apart ($91 \times 4 = 364$).

In Fig. 2 I deal with the "amplitudes" at Stonehenge, that is, the angular distance along the horizon from the E. and W. points, at which the sunrise and sunset at the solstices are seen, the equinoxes being seen at the E. and W. points themselves. But as these amplitudes vary with the latitude and therefore depend upon the place of observation, a more general treatment is possible if we deal with the declination of the sun itself, that is, its angular distance from the equator.

The maximum declination depends upon the obliquity of the ecliptic, that is, the angle between the plane of the ecliptic and that of the equator at the time of observation. When the Stonehenge Sarsen Stones were erected this angle was $23° 54' 30''$. Its mean value for the present year is $23° 27' 7''$; it is decreasing very slowly.

It will be obvious from Fig. 2 that in temples built to observe the solstices or equinoxes, if they were open at both ends, looking in one direction we should see the sun rising at a solstice or equinox, and looking in the other we should see the sun setting at the opposite one. This, however, interfered with the ceremonial, which required that the light should illuminate a naos generally dark, so, usually, two temples were built back to back, with a common axis, as at Karnak.

In the beginning of astronomical observation it was more easy to align accurately a solstitial temple than an equinoctial one.

So much, then, for the chief points in what we may term the astronomical year, those at which the sun's declination is greatest and least. We see that they are approximately ninety-one days apart—say three months.

Now the priest-astronomers in these temples could only have won and kept the respect of the agricultural population with which alone they were surrounded in early times, and by whom they were supported, by being useful to them in some way or another. This could only have been in connection with what we may term generally the *farming* operations necessary at different times of the year, whether in the shape of preparing the ground or gathering the produce.

A very large part of mythology has sprung out of the temple cults, prayer, sacrifice and thanksgiving connected with these farming operations, in different lands and ages, but it is not my purpose to touch upon this side of the question now at length.

I wish to show, however, that by studying the orientation of ancient temples erected to watch the sunrise and sunset at times other than the solstices or equinoxes an immense amount of information may be gained if we endeavour to find the way in which the problem must have been attacked before the year was thoroughly established, and when it was still a question of grass- or corn-kings or gods who had to be propitiated.

In a solstitial temple the sun only makes its appearance once a year, when it reaches its greatest "north or south" declination: but in the temples dealing with lower declinations the sun appears twice, once on its journey from the summer to the winter solstice, and again on its return.

The first difficulty of the inquiry in the direction I have indicated arises from the fact that the products of different countries vary, and that identical farming operations have to be carried on at different times in these countries. We must, then, begin with some one country, and as the record is fullest for Greece I will begin with it.

The first thing we find is that the chief points in the farmer's year in Greece are about as far from the fixed points in the astronomical year as they well can be.

In the Greek information so admirably collated by M. Ruelle in the article on the calendar in Daremberg and Saglio's monumental "Dictionnaire des Antiquités Grecs et Romains," the earlier Gregorian dates on which the seasons were reckoned to commence in ancient Greece were as follows:—

Summer	May 6
φθινόπωρον	August 11
Winter	November 10
Spring	February 7

I may also add from the same source that in the calendars of the Latins the dates become:—

Summer	May 9
Autumn	August 8
Winter	November 9
Spring	February 7

Now we see at once that these dates are, roughly, half-way between the solstices and equinoxes.

This, then, at once brings us back to the orientation problem, which was to fix by means of a temple in the ordinary way dates nearer to these turning points in the local farmer's years than those fixed by the solstitial and equinoctial temples.

It must be borne in mind that it is not merely a question of stately piles such as Karnak and the Parthenon in populous centres, but of the humblest dolmen or stone circle in scattered agricultural communities, which were as certainly used for orientation purposes, that is, for recording the return of some season of the year important to the tiller of the soil, the advent of which season could be announced to outlying districts by fire signals at night.

I have already pointed out that any temple, dolmen or cromlech pointed to a sunrise or sunset at any dates between the solstices will receive the sunlight twice a year.

If the temple is pointed nearly solstitially the two dates at which the sun appears in it will be near the solstice; similarly, for a temple pointed nearly equinoctially the dates will be near the equinox; but if the ancients wished to divide the ninety-one days' interval between the solstice and equinox, a convenient method of doing this would be to observe the sun at the half-time interval, such that the same temple would serve on both occasions. This could be done by orienting the temple to the sun's place on the horizon when it had the declination 16° 20′ on its upward or downward journey.

What, then, are the non-equinoctial and non-solstitial days of the year when the sun has this declination?

They are, in the sun's journey from the vernal equinox to the summer solstice and back again,

May 6 and August 8 ... ... Sun's decn. N. 16° 20′.

Similarly, for the journey to the winter solstice and return we have

November 8 and February 4 ... Sun's decn. S. 16° 20′.

We get, then, a year symmetrical with the astronomical year, which can be indicated with it as in Fig. 3, a year roughly halving the intervals between the chief dates of the astronomical year.

With regard to the dates shown I have already pointed out that farming operations would not occur at the same time in different lands; that ploughing and seed time and harvest would vary with crops and latitudes; and I must now add that when we wish to determine the exact days of the month we have to struggle with all the difficulties introduced by the various systems adopted by different ancient nations to bring together the reckoning of months by the moon and of years by the sun.

In more recent times there is an additional difficulty owing to the incomplete reconstruction of the calendar by Julius Cæsar, who gave us the Julian year. Thus, while the spring equinox occurred on March 21 at the time of the Council of Nice, in 325 A.D., by the year 1751 the dating of the year on which it took place had slipped back to the 10th. Hence the Act 24 George II. c. 23, by which September 2, 1752, was followed by September 14 instead of by the 3rd, thus regaining the eleven days lost. This change from the so-called "old style" to the "new style" is responsible for a great deal of confusion.

Another cause of trouble was the forsaking by the Jews of the solar year, with which they commenced, in favour of the Babylonian lunar year, which has been continued for the purposes of worship by Christians, giving us "movable feasts" to such an extent that Easter Day, which once invariably marked the spring equinox, may vary from March 22 to April 25, and Whit Sunday from May 10 to June 13. It is at once obvious that no fixed operations of Nature can be indicated by such variable dates as these.

Hence in what follows I shall only deal with the months involved; these amply suffice for a general statement, but a discussion as to exact dates may come later.

With regard to the astronomical year it may be stated that each solstice and equinox has in turn in

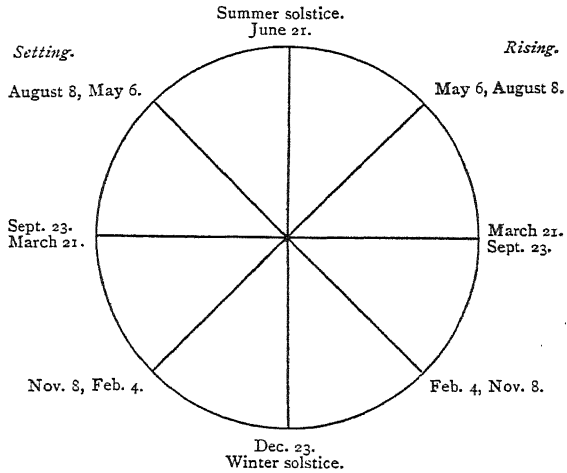


FIG. 3.

some country or another, and even in the same country, been taken as the beginning of the year.

We have, then, the following, so to speak, astronomical years:—

Solstitial Year.	June...........	December...............	June
	December ...	June	December
Equinoctial Year.	March	September	March
	September ...	March	September

Next, if we treat the intermediate points we have found in the same way, we have the following vegetation years:—

Flower Year.	May	November	May
	November ...	May	November
Harvest Year.	August	February	August
	February	August............	February

It will have been gathered from Fig. 3 that the temples or cromlechs erected to watch the first sunrise of the May–November–May year could also perform the same office for the August–February–August year; and in a

stone circle the priests, by looking along the axis in an opposite direction, could note the sunsets marking the completion of the half of the sun's yearly round in November and February.

Now to those who know anything of the important contributions of Grimm, Rhŷs, Fraser, and many others we might name, to our knowledge of the mythology, worships and customs in the Mediterranean basin and western Europe, an inspection of the first columns in the above tables will show that here we have a common meeting ground for temple orientation, vegetation and customs depending on it, religious festivals and mythology. From the Egyptian times at least to our own a generic sun god has been specifically commemorated in each of the named months. Generic customs with specific differences are as easily traced in the same months; while generic vegetation with specific representatives proper to the season of the year has been so carefully regarded that even December, though without May flowers or August harvests, not to be outdone, brings forward its offering in the shape of the berries of the mistletoe and holly.

With regard especially to the particular time chosen for sun-worship and the worship of the gods and solar heroes connected with the years to which I have referred, I may add that a cursory examination of Prof. Rhŷs' book containing the Hibbert lectures of 1886, in the light of these years, used as clues, suggests that in Ireland the sequence was May–November (Fomori and Fir Bolg), August–February (Lug and the Tuatha Dé Danann), and, lastly, June–December (Cûchulainn). Should this be confirmed we see that the farmers' years were the first to be established, and it is interesting to note that the agricultural rent year in many parts of Ireland still runs from May to November. It is well also to bear in mind, if it be established that the solstitial year did really arrive last, that the facts recorded by Mr. Fraser in his "Golden Bough" indicate that the custom of lighting fires on hills has been in historic times most prevalent at the summer solstice; evidently maps showing the geographical distribution of the May, June and August fires would be of great value.

Some customs of the May and August years are common to the solstitial and equinoctial years. Each was ushered in by fires on hills and the like; flowers in May and the fruits of the earth in August are associated with them; there are also special customs in the case of November. In western Europe, however, it does not seem that such traditions exist over such a large area as that over which the remnants of the solstitial practices have been traced.

I have pointed out that both the May and August years began when the sun had the same declination (16° N.) or thereabouts; once, on its ascent from March to the summer solstice in June, again in its decline from the solstice to September. Hence it may be more difficult in this case to disentangle and follow the mythology, but the two years stand out here and there.

With regard to August, Mr. Penrose's orientation data for the panathenæa fix the 19th day (Gregorian) for the festival in the Hecatompedon; similar celebrations were not peculiar to western Europe and Greece, as a comparison of dates of worship will show.

Hecatompedon	April 28	and	August 16
Older Erectheum	April 29	,,	August 13
Temple of Min, Thebes ...	May 1	,,	August 12
,, Ptah, Memphis ...	April 18	,,	August 24
,, ,, Annu ...	,,	,,	,,
,, Diana, Ephesus ...	April 29	,,	August 13

In the above table I have given both the dates on which the sunlight (at rising or setting) entered the temple, but we do not know for certain, except in the case of the Hecatompedon, on which of the two days the temples were used; it is likely they were all used on both days, and that the variation from the dates proper to the sun's declination of 16° indicates that they were very accurately oriented to fit the local vegetation conditions in the most important and extensive temple fields in the world.

This is the more probable because the Jews also after they had left Egypt established their feast of Pentecost fifty days after Easter = May 10,[1] on which day loaves made of newly harvested corn formed the chief offering.

With regard to the equinoctial year, the most complete account of the temple arrangements is to be found in Josephus touching that at Jerusalem. The temple had to be so erected that at the spring equinox the sunrise light should fall on, and be reflected to the worshippers by, the sardonyx stones on the high priest's garment. At this festival the first barley was laid upon the altar.

But this worship was in full swing in Egypt for thousands of years before we hear of it in connection with the Jews. It has left its temples at Ephesus, Athens and other places, and with the opening of this year as well as the solstitial one the custom of lighting fires is associated, not only on hills, but also in churches.

Here the sequence of cult cannot be mistaken. We begin with Isis and the young sun-god, Horus, at the pyramids and we end with "Lady day," a British legal date; while St. Peter's at Rome is as truly oriented to the equinox as the pyramids themselves, so that we have a distinct change of cult with no change of orientation.

If such considerations as these help us to connect Egyptian with Celtic worships we may hope that they will be no less useful when we go further afield. I gather from a study of Mr. Maudslay's admirable plans of Palenque and Chichén-Itzá that the solstitial and farmers' years' worships were provided for there. How did these worships and associated temples with naos and sphinxes get from Egypt to Yucatan? The more we know of ancient travel the more we are convinced that it was coastwise, that is, from one point of visible land to the next. Are the cults as old as differences in the coast-lines which would most easily explain their wide distribution?

NORMAN LOCKYER.

(*To be continued.*)

HABITS OF INSECTS.[2]

SEVEN volumes of M. Fabre's observations on insects have been published between 1879 and 1890, under the title of "Souvenirs Entomologiques," containing the results of long and patient investigations into the habits of insects of the south of France; and we are glad to see the first volume translated into English in its entirety. It is much better to begin at the beginning, rather than to issue merely a selection from the seven volumes, which was what we had expected to find when we opened the book. The English edition is tastefully got up, and the illustrations are attractive. We may say that there are none in the French except a few text-illustrations in some of the later volumes of the series. The English title, "Insect Life," is, however, somewhat objectionable, as there are already other English and American books bearing the same title.

The first volume, now to be noticed, includes twenty-two chapters, relating to the habits of the Sacred Beetle,

[1] Compare this with the fifty maidens who ran away from the Ultonian court (Rhŷs, "Hibbert Lectures," p. 434).

[2] "Insect Life: Souvenirs of a Naturalist." By J. H. Fabre, Docteur ès Sciences. Translated from the French by the author of "Mademoiselle Mori." With a preface by David Sharp, M.A., F.R.S., and edited by F. Merrifield. With illustrations by M. Prendergast Parker. Pp. xii+320. (London: Macmillan and Co., Ltd., 1901.) Price 6s.

various fossorial Hymenoptera of the genera Cerceris, Sphex, Ammophila and Bembex, and the Mason Bees of the genus Chalicodoma; and the volume is varied by autobiographical reminiscences, and an account of an ascent of Mont Ventoux. It is interesting to learn that M. Fabre's enthusiasm for entomological investigation was excited by his accidentally meeting with a pamphlet of Léon Dufour's on the habits of Cerceris as long ago as 1843. These observations, as the present volume shows, M. Fabre continued and completed with great success.

As regards the Sacred Beetle, M. Fabre considers that he has quite disproved the old idea that the balls of dung rolled by the beetle ever contain eggs; they are simply stores of food, and the real nest prepared for the egg is constructed underground later in the year.

M. Fabre's observations on the limitations of instinct in Hymenoptera are most curious and interesting, but are too long to be discussed here in detail; for these the book itself must be consulted. Suffice it to say, however, that they throw no light on the real nature of instinct, which remains more mysterious than ever; but only illustrate its manner of working.

The translation is very readable, sufficiently so to arrest the attention of a mere child who feels an interest in insects, notwithstanding that it sometimes deals with problems that no man living can yet answer. As an instance of the style of the book we will quote a portion of M. Fabre's account of the Praying Mantis:—

"A word more of the 'Praying Mantis,' the *Prégo Diéou*, as it is called in Provence, *i.e.* the Pray-to-God. And indeed its long pale green wings, like ample veils, its head upraised to heaven, its arms folded and crossed on its breast, give it a false resemblance to a nun in ecstatic devotion. All the same, it is a ferocious creature, bent on carnage. Although not especially favourite hunting-grounds, the workshops of various burrowing Hymenoptera are often visited by it. Posted on some bush near the burrows, it waits until chance brings some Sphex returning home within reach, thus achieving a double capture, catching together Sphex and prey. Its patience is long tried; the Sphex is suspicious and on her guard, but from time to time a rash one lets herself be caught. By a sudden rustle of half-spread wings, as by a convulsive movement, the Mantis terrifies the approaching Sphex, which hesitates for a moment, and then with the suddenness of a spring the toothed forearm folds back on an arm also toothed, and the insect is seized between the blades of the double saw, as though the jaws of a wolf-trap were closing on the beast as it takes the bait. Then, without unclosing the cruel machine, the Mantis gnaws little mouthfuls of its victim. Such are the ecstasies, the prayers, and the mystic meditations of the *Prégo Diéou*."

We hope the work will be completed by the translation of the remaining volumes of the series. At the same time, we regret to note that a few glaring technical errors in the translation have escaped notice. "Pattes" is usually translated "feet," but in almost every case "legs" would be the proper rendering. But what are we to think of such a passage as this, on p. 36, where the word "doigt" of the original, used for the five-jointed tarsus, is translated "claw"? "One claw to each foot is the rule, and this claw, at least in the case of the superior Coleoptera, especially the scavenger beetles, contains five joints." Again, in chapter ix., it is clear that the translator does not understand the real meaning of the terms "grillon," "criquet" and "acridien," and has sadly mixed them up, reversing "grasshoppers" and "crickets" in more than one passage. But when we object to "*Bupresticis micans* and *Buprestis flavomaculata*" beneath the plate opposite p. 46, we have exhausted our fault-finding, and warmly recommend the book to the attention of all who are interested in the habits of insects, and the many curious problems which they offer for our investigation.

FIG. 1.—The Sphex of Languedoc and its enemy, the Praying Mantis.

SOME SCIENTIFIC CENTRES.

III.—THE LABORATORY OF HENRI MOISSAN.

THE isolation of the element fluorine in 1886, the result of a long series of investigations carried out with an enthusiasm and manipulative skill and natural resourcefulness amounting to genius, has ensured Henri Moissan a high place in the history of modern chemistry.

His appointment in 1900 to fill the chair at the Sorbonne, rendered famous by its association with the names of the illustrious Dumas and Sainte-Claire Deville, sets a seal on a career of splendid activity.

Born in Paris in the year 1852, he commenced the systematic study of chemistry in the laboratory of the late M. Paul Dehérain at the Muséum d'Histoire naturelle. His first researches were in the direction of vegetable physiology, and in 1874 he made his *début* in a paper on the respiration of plants.

In the meantime, from 1872 until 1876, he was attending the course of Henri Sainte-Claire Deville. Under the influence of this teacher his interest was aroused in "la chimie minérale," and he carried out several investigations on the nature of the various oxides of iron, amalgams and the salts of chromium.

Obtaining his degree of "Docteur ès Sciences" in 1880, he received an appointment on the staff of the École de Pharmacie as "chef des travaux pratiques de I^{re} année." In spite of the laborious routine duties of his position, he found time to commence the examination of some of the compounds of fluorine "in the uncertain hope of at last being able to isolate the element." The next three years find him engaged on the problem which had baffled investigators from the time of Davy onwards. With patient and indefatigable zeal he continued, bearing up under repeated failure, and accumulating that valuable experience which enabled him to triumph over difficulties, and in 1886 to announce to the world that his efforts had been crowned with success. Fluorine was at length a chemical fact.

Before going on to describe the experiments by which Moissan led up to his final result, it will be interesting to glance at the attempts of previous workers and view them in the light of later discoveries; we shall then be in a better position to appreciate the value and the scope of his research.

Margaff and Scheele commenced the investigation of hydrofluoric acid in the latter half of the eighteenth century. Davy devoted considerable time to the isolation of the hypothetical element, and suffered a severe illness from breathing the fumes of the acid: he advised chemists to take special precautions against its action on the skin and lungs. Gay Lussac and Thénard fared in the same way. Knox, after repeating the work of Aimé, a French chemist, who attempted to replace fluorine by chlorine in silver fluoride, had to recruit his health in Italy for three years. Louyet, the next worker on the subject, paid the price of his enthusiasm with his life.

Frémy, in 1850, was the first to obtain anhydrous hydrofluoric acid, but the failure of his laborious researches seemed only to discourage further efforts in that direction; and, with the exception of some work by Gore in 1869, nothing more was attempted. Chemists accepted the inevitable, and were content to wait. Moissan, in approaching the subject in 1880, may be supposed to have recognised the dangers as well as the difficulties of his task.

The various experiments which culminated in the isolation of the element fall under four headings.

First of all Moissan made use of the fact that the high temperature of the electric spark is often capable of splitting up binary compounds into their constituent elements. He tried its effect on certain gaseous fluorides. Those of silicon and carbon were unaffected by it. The trifluoride of phosphorus was decomposed, probably into phosphorus and fluorine, but the latter element immediately combined with the excess of undecomposed trifluoride, and yielded the pentafluoride; thus

$$5PF_3 = 3PF_5 + 2P.$$

He then tried the pentafluoride, but found it far more stable than the corresponding chloride. It only split up under the influence of a very strong spark. Since the experiment had to be made in a glass vessel over mercury, it resulted only in the formation of the fluorides of mercury and silicon.

The trifluoride of arsenic was equally unsatisfactory. It was vaporised and sparked. There was reason to believe that decomposition occurred, but from the conditions of the experiment it was impossible to isolate the element.

Moissan now adopted a different plan of attack. Frémy had noticed that platinum fluoride, produced accidentally in one of his experiments, splits up under the influence of heat into platinum and fluorine. It was only logical to assume that, if the fluoride could be formed at a dull red heat, a sudden rise in temperature would result in the liberation of the element. The difficulty, however, was to obtain the platinum fluoride. On heating platinum in a current of the trifluoride of phosphorus, combination occurred, but not in the way desired, the chief product being a fluorophosphide of platinum.

Similar experiments with the pentafluoride of phosphorus indicated the hopelessness of expecting the desired result from work carried on at so high a temperature.

Moissan now had recourse to electrolysis. In the first instance he used trifluoride of arsenic contained in a platinum vessel, and found that if the material were quite pure and dry (B.P. 63°) it was decomposed into its elements. The fluorine, however, combined at once with the undecomposed trifluoride to form the pentacompound, while the arsenic sank to the bottom of the vessel, or remained suspended in the form of fine particles in the liquid.

It was found impossible to prepare the pentafluoride of arsenic by any chemical process, so that this substance, which would probably have solved the difficulty, had to be abandoned. The extremely poisonous nature of the arsenic compounds also rendered it desirable, if not indeed necessary, to find some more convenient electrolyte.

Moissan now returned to the early experiments of Davy, and took up the investigation of the effect of the electric current upon hydrofluoric acid. As both products of the electrolysis might be expected to be gaseous, a platinum U-tube had to be employed, so that the gases could be separated at the moment of their liberation. Further, to ensure the complete liquefaction of the acid, which boils at $+19^{\circ}\cdot5$ C., the apparatus was immersed in a bath of methyl chloride (B.P. -23° C.).

His first experiments confirmed the results which Davy had obtained, and which later on Faraday and Gore had explained, viz. that the anhydrous acid is a non-conductor. Moissan showed, in addition, that if the acid contains a small quantity of water, this latter is decomposed, until only the anhydrous acid remains in the U-tube, when the current ceases to pass. It was necessary, therefore, to add to the acid some substance which would enable it to conduct the electricity; such a substance is the acid potassium fluoride having the formula KF . HF. This can be obtained quite pure, and is very soluble in the anhydrous acid.

By this means it was found possible to decompose the hydrogen fluoride. The fluorine, however, immediately attacked the corks which had been covered with paraffin. Fluorspar stoppers were therefore substituted, and the experiment repeated. Hydrogen was evolved at the negative pole. In the other limb there collected an

apparently colourless gas with a penetrating disagreeable odour resembling that of hypochlorous acid. It was endowed with exceedingly active chemical properties. Hydrogen combined with it with explosive violence; most of the non-metals burnt in it, while the metals were less vigorously attacked. All organic substances were immediately decomposed.

Three hypotheses suggested themselves as to the nature of the gas. First, that it was a mixture of ozone and hydrofluoric acid. No such mixture, however, was found to exhibit the properties already described. Secondly, that it was a perfluoride of hydrogen; and thirdly, that it was the wished-for fluorine itself. This last point was settled by studying the action of water on the gas.

In the first case

$$\underset{4\text{ vols.}}{2HF_2} + H_2O = 4HF + \underset{1\text{ vol.}}{O}.$$

In the second

$$\underset{2\text{ vols.}}{F_2} + H_2O = 2HF + \underset{1\text{ vol.}}{O}.$$

By measuring the volume of oxygen liberated and titrating the quantity of hydrofluoric acid formed, Moissan was able to decide in favour of the third hypothesis: the gas must be fluorine.

The value of this work was at once recognised. Moissan was rewarded with the chair of "Toxicologie" at the "École de Pharmacie." "J'avais donc," he says, in a letter to the present writer, "très jeune un laboratoire, et un préparateur; quelques élèves vinrent se grouper autour de moi, et toute mon ambition fut satisfaite."

His faculties now had free play; he was able to work on a wider basis, and became one of the most prolific contributors to the *Comptes rendus*.

The isolation of fluorine was naturally followed by a systematic examination of its properties and derivatives. This work is still being carried on; recently, however, M. Moissan collected and published in one volume[1] the results he has obtained. They are all interesting, and some of great theoretical importance.

He found it more convenient and less costly to carry out the electrolysis of the anhydrous acid in a U-tube made of copper immersed in a mixture of acetone and solid carbonic acid, *i.e.*, at a temperature of -50° C. The electrodes as before were of platinum isolated from the apparatus by means of stoppers of fluorspar. The fluorine thus obtained was purified by passing it through a spiral cooled to -50° C., and then through a horizontal tube containing fragments of sodium fluoride; thus the hydrofluoric acid was removed. Perfectly dry fluorine which has been passed through a spiral immersed in liquid air, to solidify any traces of hydrofluoric acid remaining, has no action on dry glass even at the ordinary temperature.

It possesses a slightly greenish-yellow colour, paler than that of chlorine. It unites with greater or less violence with all the non-metals save oxygen, nitrogen and argon; the compounds being sometimes gaseous, and sometimes solid. The tri-, penta- and oxy-fluorides of phosphorus have been studied very completely; as also the fluoride of arsenic (AsF_3) and the tetrafluoride of carbon.

In the case of the metals the action is not so energetic, the solid fluoride formed on the surface of the metal preventing further combination.

The metals of the alkalis and alkaline earths take fire in the gas; lead combines slowly. Magnesium, aluminium, nickel and silver on slightly heating burn brightly on contact with the gas. Manganese heated in a current of fluorine yields a sesquifluoride, Mn_2F_6; this on further heating splits up into the difluoride, MnF_2, and liberates fluorine. Gold and platinum are unattacked in the cold, but combine at a dull red heat; the platinum fluoride has the formula PtF_4; at a higher temperature the gold and platinum compounds are decomposed into fluorine and the respective metal.

FIG. 1.—Prof. Moissan in his private laboratory.

Organic compounds rich in hydrogen are violently attacked by fluorine, and totally decomposed into hydrofluoric acid, and fluorides of carbon. Organic acids are attacked more slowly; amines and alkaloids are rapidly burnt up or decomposed into volatile products.

By indirect reactions involving the use of the fluorides of silver and zinc, Moissan and Meslans have been able to prepare and examine the properties of methyl, ethyl and isobutyl fluorides, fluoroform, acetyl fluoride, and a few other derivatives.

The latest determination gives the atomic weight of the element as 19·05.

A general survey of its chemical and physical properties confirms the surmises of Ampère and Davy: fluorine falls naturally into place at the head of the so-called "natural group" chlorine, bromine, and iodine.

[1] "Le Fluor et ses composés." Par Henri Moissan. (G. Steinheil, Paris, 1900.)

In 1896, Moissan and Dewar, working in collaboration, effected the liquefaction of fluorine by passing it through a tube cooled in liquid air which was allowed to boil freely. The B.P. of liquid fluorine is about -187°. The liquid does not solidify even at -210°. Its density is 1·14; it exhibits no absorption spectrum, and is not magnetic. It is soluble in all proportions in liquid air and oxygen. Liquid fluorine has no chemical action on liquid oxygen, solid mercury, or ice; but even at -210° it combines with hydrogen, and decomposes benzene with violence, and production of light and heat. It would be interesting to know the order in which the elements cease to react with fluorine as the temperature falls.

We must also refer to the hexafluoride of sulphur prepared by Moissan and Lebeau in April of 1900. It is obtained by the action of excess of fluorine on sulphur; it is one of the heaviest gases known, having a density of 5·03. Its composition, which is represented by the formula SF_6, completely establishes the hexatomic nature of the sulphur atom. It is of interest also on account of its inertness; it is unattacked by fused sodium or potassium. Resulting as it does from the union of two such active elements as sulphur and fluorine, which in combining seem thus to saturate one another completely, this compound may be regarded as additional evidence in favour of the theory of valency, though a chemical Ishmael might view it in a different light.

While engaged in studying the compounds of fluorine, Moissan's interest was aroused in the element boron; he obtained the amorphous variety in quantity, and caused it to unite with iodine, sulphur and phosphorus; he examined the action of alkali metals on boric acid, and, as we shall see later, in speaking of the electric furnace, prepared the carbide BC.

In 1891 the coveted honour of a seat in the Académie des Sciences was conferred upon him in recognition of his brilliant work. Cahours had died. To fill his place the names of Moissan, Grimaux, Ditte, Jungfleisch and Le Bel were submitted to the Comité. After a discussion lasting nearly two hours it was decided to nominate Moissan and Grimaux for election. The latter was defeated by eleven votes, and Moissan became the *confrère* of Berthelot, Friedel, Schützenberger and Troost.

The difficulty which was now hampering his work was one of temperature; he required a source of heat greater than that obtainable from the oxyhydrogen flame, and had recourse to the electric arc. In 1892 he devised the electric furnace, by means of which in its more perfect form a temperature of 3500° C. could be readily attained. The first result was the production of uranium from its oxide in fair quantities. Metals hitherto considered refractory yielded at once to the intense heat, and the electric furnace became in his hands the source of good specimens of chromium, tungsten, titanium, molybdenum, vanadium, zirconium, &c., all obtained from their oxides by reduction with charcoal.

In the following year, 1893, came the production of artificial diamonds, and Moissan's name became the prey of newspaper men and popular lecturers; chemistry began to appeal to the man in the street.

Moissan now took up the compounds of carbon with the metals, and obtained a whole series, comprising the carbides of sodium, potassium, calcium, strontium, barium, yttrium, lanthanum, thorium, aluminium, titanium, zirconium, chromium, uranium and manganese, and of the metalloids, boron and silicon. Quite recently he has added the carbides of neo- and praseo-dymium to the list. Proceeding in the same way with silicon and boron, he prepared the silicides of iron, chromium, tungsten, titanium, molybdenum, &c., and the borides of iron, nickel, cobalt, titanium, molybdenum, calcium, strontium and barium.

In 1898 he succeeded in his efforts to make calcium assume the crystalline form by dissolving it in sodium at a dull red heat, and dissolving away the sodium by absolute alcohol; from this crystalline variety he was able to pass to the hydride, nitride and phosphide of the element. By the electrolysis of fused calcium iodide he was the first to obtain the metal calcium in a state of purity.

When this series of experiments is completed, we shall be in a position to generalise from his results. Not the least interesting feature of the work is the bearing it will have on the Periodic classification; in this connection it should be of supreme importance.

But for the present we must be content with this necessarily brief *résumé* of the scientific work of Henri Moissan. As an experimenter he is unrivalled. "J'avais commencé à manipuler," he says, "de l'âge de 14 à 15 ans; et mes premières leçons de chimie, données par mon père, sont encore gravées dans ma mémoire." He is no theorist in the ordinary sense of the word. His work has been confined to the sphere of the purely practical; and for him a theory exists only that it may be submitted to the test of rigorous experiment, and for the sake of what it leads to. We can conceive of him working out a theory for the origin of diamonds; we find it difficult to conceive of him formulating a theory for the origin of man.

Unlike his distinguished compatriots, M. Berthelot and the late C. Friedel, who worked in both fields, organic and inorganic, Henri Moissan has remained true to the enthusiasm inspired by his first great teacher, Deville. "Je me suis appliqué à cultiver cette chimie minérale que l'on croyait épuisée, et je pense que mes travaux, ainsi que les belles recherches des savants anglais, ont pu démontrer que cette science réserve encore bien des dècouvertes à ceux qui voudront l'aimer et l'étudier avec tenacité." "To love it and pursue it with zeal" is the secret of Moissan's success, as it was of that of Davy and Faraday and Lavoisier.

In the midst of the gayest capital of Europe, but untouched by all the vicissitudes of its political life, he lives and works. "Ma vie a eu toute la simplicité de ma carrière de professeur, et mon existence s'est partagée, heureuse jusqu'ici, entre mon laboratoire et ma maison."

We can only wish him a continuance of this happiness, and in his new sphere an equal measure of success. The Science Faculty of the University of Paris is to be congratulated on the acquisition of so eloquent and so distinguished a teacher.

NOTES.

THE Geological Society of London will this year award its medals and funds as follows:—The Wollaston medal to M. Friedrich Schmidt of St. Petersburg, the Murchison medal to Mr. F. W. Harmer, and the Lyell medals to Mr. R. Lydekker and Prof. Anton Fritsch, of Prague; the Wollaston fund to Mr. L. J. Spencer, the Murchison fund to Mr. T. H. Holland, the Lyell fund to Dr. Wheelton Hind, and the Barlow-Jameson fund to Mr. W. M. Hutchings.

PROF. J. H. MARSHALL, who for three years past has been associated with Mr. Bosanquet in archæological researches at Athens, has been appointed Director-General of the Archæological Survey of India, for a period of five years in the first instance.

THE objects found during the recent excavations at Stonehenge will be on view in the library of the Anthropological Institute, Hanover Square, until January 21.

A MEDALLION bust of Sir George Airy is to be placed in the north-east wall of St. Alphage Parish Church, Greenwich, by his daughters. The bust has been copied from the one in the Royal Observatory, Greenwich.

WE regret to see the announcement that Mr. Clarence King, the eminent geologist, died at Phœnix, Arizona, on December 24, 1901. Mr. King was born in Newport, R.I., and graduated from the Sheffield Scientific School of Yale University in 1852. He was instrumental in the organisation of the U.S. Geological Survey, of which he was director from 1878 to 1881.

WE learn from the *Victorian Naturalist* that the monument erected over the grave, in the St. Kilda Cemetery, of the late Baron Sir F. von Mueller, K.C.M.G., for nearly forty-five years Government Botanist of Victoria, was unveiled on November 26, 1901, by His Excellency the Govenor-General, Lord Hopetoun, in the presence of a large gathering of public and scientific men and personal friends. The monument is in the form of a tall column of polished stone, surmounted by an urn, and resting on a broad pedestal. A medallion in copper of the profile of the late Baron is let into the stone above the inscription.

IT is reported from Paris that M. Ducretet is engaged in carrying out experiments on wireless telephony from which he has already obtained results which he considers are very promising. M. Ducretet's name has been associated with that of M. Popoff in connection with some very successful work in the development of wireless telegraphy. His present experiments do not seem to have gone beyond the laboratory stage, the distance over which speaking has been conducted being only thirty yards. The telephone currents pass through the ground, and it is said that M. Ducretet is about to investigate the conduction through different soils. We hope that he will meet with success, though we are inclined to doubt the practical utility of such a telephonic system, as it is difficult to see in what way, except as a scientific curiosity, it is likely to be superior to present methods.

IT is announced in *Science* that Dr. Ales Hrdlicka is about to start on his fourth expedition among the Indians of the south-western United States and northern Mexico. These expeditions are a part of the system of anthropological exploration and investigation known as the Hyde Expedition, and are carried on under the direction of Prof. F. W. Putnam for the American Museum of Natural History. The expenses of the present undertaking are generously provided for by Mr. F. E. Hyde, jun., of New York City. Dr. Hrdlicka is in charge of the somatological work of the Hyde Expedition, and his plan, now more than half fulfilled, is, in the main, to ascertain the physical characteristics of the extinct as well as the living peoples in that area which has once been occupied by the Cliff-Dwellers and Pueblos, and by the Toltec, Aztec and Chechemec peoples. It is hoped that on the present journey the somatological part of the research in the field will be completed.

DR. J. EVERETT DUTTON, of the Liverpool Malaria Expedition to the Gambia River, gives in a short report a few details of a peculiar case of fever in which he found a parasite resembling that of "tsetse fly disease" of cattle. The case was that of a European, who presented peculiar symptoms, namely: "Irregular attacks of fever lasting over a few days, the temperature not exceeding 101°. The attacks occurred irregularly for a period of some months; abnormal frequent pulse; an increased frequency of respiration, especially on exertion, were noticed. Besides general weakness there was a peculiar œdema of the eyelids and a puffiness about the face, as well as œdema of the legs. The spleen was enlarged, but there were no organic lesions of the heart or kidney, and the urine was normal. An examination of the blood revealed, in somewhat scanty numbers, a parasite, which actively travelled across the field of the microscope backwards or forwards, butting against the red corpuscles, and which was roughly determined to measure 20μ long and 3μ broad. The anterior end tapered off into a long cilium; the lateral membrane was distinct. A drop of blood under a cover glass contained some four to fifteen organisms." The organism is certainly a Trypanosome, but whether *Trypanosoma lewisi* or *T. brucei* or a new species is not yet certain. A single stained blood specimen accompanying the report shows an organism having a long anterior cilium and a rather blunt posterior end. The case was seen and the blood examined several times at the Royal Southern Hospital in September last, but no parasite of any sort could then be demonstrated in the blood. The fever on that occasion was also peculiar.

SOME observations on the seiches of the lake of Lucerne, by M. Ed. Sarasin, of Geneva, are described in the recently issued *Comptes rendus de la Société helvétique*, containing the proceedings for 1899. These observations, which were made at Lucerne, Fluelen and near Vitznau, showed that the period of the uninodal oscillation was 44 minutes, and of the binodal 24 minutes.

A CIVIL SERVICE examination in statistics was held for the first time in June, 1901, in connection with an open competition for the situation of assistant to the head of the statistical branch of the Board of Agriculture. It has been, therefore, considered of interest to reprint the papers both in this subject and in political economy in the *Journal* of the Royal Statistical Society for 1901.

THE preliminary report as to the population of England and Wales in 1901 is discussed by Mr. Thomas A. Welton, in the *Journal* of the Royal Statistical Society for December 31. In the ten years 1891–1901 the increase has been about 12·15 per cent. The large towns have more than held their own, and the new places noted in 1891 have maintained an average high rate of increase. This has been shared by many places which, though they had but from 1000 to 2000 inhabitants in 1801, were nevertheless classed as "progressive." On the other hand, all the towns treated as "unprogressive" in 1801–1891 have shown poor rates of increase, as have also many "progressive" towns which numbered from 2000 to 4000 inhabitants in 1801.

THE *Journal de Physique* for January contains a short abstract of a paper by P. van der Vlieth on an apparatus for demonstrating the linear conduction of heat, the original paper being in the *Journal* of the Russian Physico-Chemical Society. A bar of iron of section 5×5 cm. is heated by a jet of steam at one end and cooled at the other by a stream of water. Its lateral surface is covered by a thick coating of felt and cork, and a series of six thermometers is placed in holes made in the bar. After about half an hour the distribution of heat is stationary, and the temperature gradient as shown by the thermometers is almost exactly a straight line.

PROF. P. ZEEMAN, writing in the *Archives néerlandaises*, describes an experiment relating to the change of phase which occurs when a pencil of light-waves passes through a focus or focal line, a phenomenon to which Gouy has given the name of anomalous propagation. The experiments were made with a plano-convex lens of Iceland spar placed between two crossed nicols, and consisted in observing the rings produced by interference of the ordinary and extraordinary rays. When the centre of the system is black or white between the two foci, M. Gouy's theorem shows that it must be white or black respectively beyond the foci. Prof. Zeeman also gives an independent mathematical investigation of the phenomenon based on treating the focus as a doublet.

A HISTORICAL and critical essay of considerable length, on the definitions of the Bernouillan function, has been published by Prof. H. Renfer, of St. Gallen, in the *Mittheilungen der*

naturforschenden Gesellschaft in Bern for 1900, of which Messrs. Williams and Norgate have forwarded a copy. The essay consists in a detailed examination of the treatments of Raabe, Schlömilch, Schäfli and J. W. L. Glaisher, and the author gives tables as well as graphs of the functions according to the four corresponding alternative definitions. As a result of the examination, Prof. Renfer decides that L. Schäfli's definition is to be preferred on account of (1) its wider limits of convergency, (2) the greater simplicity of form of the formulæ, (3) this form being the most general, and (4) the theory assuming a more compact form on account of the assumed fundamental relation between Bernouillan numbers and functions and the applications of the principle of indeterminate coefficients.

THE "Antonio Alzate" Society, of Mexico, has published the proceedings and reports of the first national meteorological congress held in that country, and convened under its auspices on November 1, 2 and 3, 1900. The congress was attended by thirty-one members, chiefly directors of observatories and delegates of the various States. Many questions of general interest, mostly tending to ensure uniformity in the methods employed, were discussed. Some of the reports handed in contain valuable discussions of the rainfall and climate of various localities in Mexico. A paper was also read by a lady member, Señorita R. Sánchez Suárez, on the barometer and the prediction of weather.

ON comparing the principal meteorological results of the year 1901 at Greenwich Observatory with those of the last sixty years, the mean temperature (49°·6) is found to be −0°·5 below the average; there was nothing remarkable in the absolute extremes of temperature, the maximum being 87°·9, on July 19, and the minimum, 20°·4, on February 14, giving an absolute range of 67°·5. The rainfall, as in several previous years, was below the mean, the amount of deficiency being 3·28 inches; there was a slight excess in March and April, and a large excess, 1·74 inch, in December, while deficiencies exceeding an inch occurred in January and November. The amount of bright sunshine exceeded the mean of the last twenty years by 290 hours; the largest amount was recorded in May (237 hours), and the least in February (27 hours).

IN an illustrated article on the boats of the Samoans, in *Globus* (vol. lxxx. 1901, p. 167), Prof. Thilenius points out that the remarkable migrations of the Polynesians were accomplished by means of the *alia* or double canoe. Some of these canoes can accommodate more than a hundred persons, and the type extends from Hawaii to New Zealand and from Viti to the Marquesas.

SO little is known about the brains of primitive peoples that we welcome with especial pleasure the careful study of the brain of an Eskimo man by Dr. A. Hrdlicka in the *American Anthropologist* (1901, p. 454). As a whole this brain is heavier and larger than the average brain of white men of similar stature, and the cerebrum rather exceeds that of an average white male in the number, extent and depth of the sulci and in the complexity of the gyrations.

G. PAUL-BONCOUR gives, in the *Bulletins de la Société d'Anthropologie de Paris* (v. sér. t. ii. 1901), the first of a series of studies on the skeletal modifications consequent on infantile hemiplegia. This detailed study deals with the femur, and the author gives a careful comparison of the healthy femur with that of the paralytic side of a number of subjects. The last of his conclusions is the only one that will interest the general reader; he says: "From the anthropological point of view it has been possible pathologically to establish reasonable and clear transitions between human femurs and the femurs of anthropoids."

"NOTES on the Ancient Model of a Boat and Warrior Crew found at Roos in Holderness," by Mr. Thomas Sheppard, is the title of the fourth of the *Hull Museum Publications*. This little brochure, which is illustrated by four figures and two plates, is sold to the public for one penny. The curator is to be congratulated on producing such an interesting little essay on a remarkable model, probably of Scandinavian manufacture, of a wooden boat, the prow of which is carved to represent a snake's head with small quartz eyes. On the boat are four nude male figures, each of which was originally provided with a club and a large and a small round shield; their eyes also were pieces of quartz. The figures are from 14 to 16 inches in height.

ARCHÆOLOGISTS have long been accustomed to accept the statement that there is a hiatus between the Palæolithic and Neolithic stages of culture; but of late years more detailed research has indicated evidence of a transitional culture in the south of France and elsewhere. Quite recently A. Laville has investigated sections of certain hills in the valley of the Seine, and he claims (*Bulletins et Mémoirs de la Soc. d'Anthropologie de Paris*, v. sér. t. ii. 1901, p. 206) to have discovered two layers which he terms "Infra-Neolithic." These correspond, according to him, with the layers B and C of the famous cave of Mas d'Azil, so admirably worked out by E. Piette, and to which the attention of readers of NATURE has been called. There is a second paper (p. 285) by the same author, in which he figures a specimen from a basement zone which he claims to be an implement of the Chellian type, but in which M. Verneau cannot discover any evidence of human workmanship.

FIRE is regarded by the Hopi Indians of Arizona as a living being, its cultus consisting primarily of rites for germination, and, secondarily, for rain making. The lesser new-fire ceremony, which is described by Dr. J. Walter Fewkes in the *American Anthropologist* (n.s., vol. iii. p. 438), has these two purposes. The special gods worshipped are the germ-father and the germ-mother; the former is the fire god and is communicated with by means of prayer-sticks placed in his shrine, or prayer-fires kindled in the vicinity of the same. The germ-mother, called in this ceremony by the name of her animal personation (spider woman), is communicated with by invocations consisting of archaic monosyllables shouted by the chief. The personators of the ancient priests wear face-shields or masks; the latter have magic power, and their presence on the altar is a symbolic or mute suggestion of the elaborate ceremony of the ancients.

WE have received specimens of wall maps of Africa and South America, compiled and drawn by Prof. Guido Cora and published by Messrs. Paravia and Co. These maps, which are the first of a new series, are on a scale of 1 : 8,000,000, and show the physical features correctly and clearly. Ethnographic and political maps, on a scale of 1 : 25,000,000, are shown as insets; and profiles on a vertical scale of 1 : 200,000, along the equator in the case of Africa, and the parallel of 19° S. in the case of South America, form useful additions.

THE December number of *Petermann's Mittheilungen* contains several articles of more than average general interest. Prof. Gerland writes on Italian earthquakes and Baratta's seismic map of Italy, Prof. Wieser on the oldest map bearing the name "America," and Dr. Ernest Stromer on Lake Tanganyika. Dr. Vogelgesang concludes the first part of an account of journeys in northern and central China. Dr. Henkel contributes a note on the distance limit of visibility of land of a certain elevation from the sea, and adds a map of Greece showing the limits for a number of mountain summits.

THE marine submergence of the Gobi during the Secondary period becomes more and more doubtful, in proportion as we

learn more about this region. The Russian geologist, Bogdanovich, notwithstanding a most careful search, has found during his three years' journey no traces of this submergence. Stoliczka's fossils are apparently similar to those found by the Russian explorers further north, which have proved to be Devonian. Obrucheff's fossils from the eastern Gobi belong to freshwater lacustrine deposits. And now we learn from Prof. Tschernyscheff (*Verhandlungen* of the St. Petersburg Mineralogical Society, xxxviii. 2) that the fossils brought in by D. A. Klements from the Dzungarian Gobi, from a spot, Nyursu, situated to the east of Pyevtsoff's route from Kobdo to Guchen, belong to the Permo-Carboniferous strata, which are known in the Urals as the Artinsk horizon. They contain Bryozoa (Polypora and Fenestella), the polypes *Stenopora columnaris*, var. *Ramosa multigemmata*, and the molluscs *Productus purdoni*, *P. asperulus*, *P. mexicanus*, *Chonetes transitionis*, *Rhynchopora nikitini*, *Reticularia lineata*, *Martinia semiglobosa*, *Spirifer cameratus* and *Bairdia curta*. The character of this fauna is also similar to the fauna which was found by Loczy in the provinces of Se-chuen and Yunnan.

IN the *Notes* of the Leyden Museum (vol. iv. p. 191) Dr. F. A. Jentink describes a skin of the rare Bornean bay cat (*Felis badia*), which he believes to be the fourth known specimen. In the same issue Dr. O. Finsch continues his catalogue of the ornithological collection at Leyden.

IN the *Sitzungsberichte* of the Vienna Academy (1901, No. 25), Prof. R. von Wettstein draws attention to the important zoological and botanical collections obtained by the recent expedition to south Brazil. He directs attention to the marked changes caused in the vegetation of the country by plants introduced, either accidentally or on purpose, during the last century.

IN the January number of the *Entomologist*, Mr. F. B. Dodd describes a peculiar instrument by means of which the silk-producing moths of the Australian genus Antheræa cut their way out of their hard cocoons. The instrument "is a short hard black and curved thorn, situated in the thick joints at the base of the fore-wings, one on each side; in a rubbed specimen the thorn is easily discernible, but in a good one it is concealed amongst the dense scales. . . . It would be interesting to know whether anyone can state whence the liquid issues which the moth discharges to soften the cocoon where he cuts through; it must issue from near the thorn, for, as a rule, the scales left at the base of the wing and alongside the thorax are wet and matted when the moth emerges."

TO the issue of the *Journal* of the Straits Branch of the Royal Asiatic Society for July last Captain S. S. Flower contributes an interesting series of notes on the millipedes, centipedes, scorpions and allied creatures of the Malay Peninsula and Siam. The author sets an excellent example to other naturalists in the way he grappled with an unknown subject. "When I arrived in the Straits Settlements," he writes, "in March 1895, I knew practically nothing of these animals, how they were classified, how to distinguish between them, or which were poisonous and which harmless, and in no book or paper could I find the information I wanted, so I set to work to collect and examine specimens, and compare them with such literature as was available." The result of this energy and perseverance is the long and well-annotated list before us.

MR. G. ARCHDALL REID contributes to the current number of the *Monthly Review* an instructive and clearly written account of "the rationale of vaccination." After an explanation of the causes of zymotic diseases, it is explained that there are two kinds of immunity from them—the inborn and the acquired. The former prevents infection, the latter prevents reinfection, and both kinds have arisen in the human race through a process of natural selection. When, as in the case of measles, immunity can be acquired by the individual, natural selection has evolved a power of recovering from infection. Thus, Englishmen, who have long been afflicted by measles, are as certainly infected, but recover much more easily than Polynesians, to whom the disease has only lately been introduced. After passing in review the theories which have previously been held to explain acquired immunity, Mr. Reid shows that it is due to an habituation to the toxins of that disease. This result is brought about by the digestion in the blood of the toxins, so that there are present in the animal's blood toxins in all stages of attenuation, from those newly produced by the microbes, and extremely virulent, to those produced in the beginning of the disease and now in a state of great enfeeblement. Up that graduated scale the cells of the animal react till complete immunity is attained. The serum treatment artificially supplies digestive substances and, what is even more important, a scale of attenuated toxins. Applying these principles to the case of small-pox, the necessity for periodical vaccination is established. It is pointed out that, since small-pox is an air-borne disease, isolation, by itself, has no greater power of controlling small-pox than the historic old lady with a broom had of sweeping back the Atlantic. In the absence of vaccination isolation would be worse than useless.

A NEW edition (the third) of "Practical Radiography," by Messrs. A. W. Isenthal and H. Snowden Ward, has been published by Messrs. Dawbarn and Ward. Many additions have been made to the original volume, and the position and possibilities of radiography at the present time are fairly represented. The book is a useful guide to many aspects of work with Röntgen rays, and in it the authors judiciously combine practical hints with descriptions of theoretical interest.

THE German weekly scientific periodical *Die Natur* has just commenced a new half century in its existence, the first number having appeared on January 3, 1852. The journal was founded by the late Dr. Otto Ule and Dr. Karl Müller, and has maintained a high position among scientific periodicals from the commencement. The present editor is Herr H. Behrens. The cordial relationship which has existed between the French and German periodical representatives of Nature and ourselves is one instance among many of the cosmopolitan character of scientific interests. We congratulate *Die Natur* upon its jubilee and trust that its work and influence in the future will be even more extensive than in the past.

MR. C. E. BENHAM has prepared a series of seven stereoscopic diagrams, published by Messrs. Newton and Co., illustrating the polarisation of light. These diagrams show, in stereoscopic relief, the various directions of vibration in a light-wave, the passage of a ray through a doubly refracting crystal, the action of Nicol's prisms, and polarisation by reflection. The figures are drawn in white lines on a black ground, and they should be very useful for demonstration purposes. The only fault we have to find with them is that the right-hand and left-hand blocks in several cases are of unequal size, and present in the stereoscope the appearance of pieces of black paper which have been turned up at one side and slant towards the observer instead of looking like screens placed behind the diagrams. This is particularly confusing when there are two diagrams on the same slide, and the black patches appear tilted in opposite directions.

THE additions to the Zoological Society's Gardens during the past week include a Patas Monkey (*Cercopithecus patas*), a Ground Hornbill (*Bucorvus abyssinicus*) from Kontagora, Nigeria, presented by Captain E. H. Lewis; a Common For

(*Canis vulgaris*) from Savoy, presented by M. Leon Montaigne; a White-crested Tiger-Bittern (*Tigriosoma leucolophum*) from West Africa, presented by Mrs. F. M. Hand; nine Pheasant-tailed Jacanas (*Hydrophasianus chirurgus*) from India, presented by Mr. Frank Finn; a Horned Capuchin (*Cebus apella*) from South America, a Feline Douroucouli (*Nyctipithecus vociferans*) from South Brazil, four Crowned Partridges (*Rollulus cristatus*) from Malacca, deposited; a White-tailed Gnu (*Connochaetus gnu*, ♀), born in the Gardens.

OUR ASTRONOMICAL COLUMN.

DIAMETER OF JUPITER.—In continuation of his series of determinations of planetary diameters with the 26-inch refractor at Washington, Prof. T. J. J. See gives the reduced measures of Jupiter in *Astronomische Nachrichten*, Bd. 157, No. 3757. The observations were made during daylight, using the colour screen over the eye-piece for eliminating the secondary fringes, &c. For the final evaluation of the diameter sixty-eight measures are employed, extending over the period 1901 September 6–October 1; from these he gives:—

$$\text{Equatorial diameter of Jupiter} = 37''{\cdot}646 \pm 0''{\cdot}014 = 141{,}950 \pm 53 \text{ km.}$$

Prof. See thinks this very closely approximates to the absolute value of the diameter, and by comparing it with the value obtained at night, when the planet is seen as a very brilliant object on a dark background, he obtains a measure of the irradiation. The night value is $38''{\cdot}40$, which gives for the irradiation:—

$$I = 0''{\cdot}755 \pm 0''{\cdot}040 = 2847 \pm 150 \text{ km.}$$

As these values are so different, the suggestion is made of the advisability of adopting two sets of planetary diameters, one representing the apparent size of the planet as seen at night, to be used in physical observations and ephemerides, work on satellites, &c., the other representing the true dimensions of the spheroid independent of its illumination by the sun, to be employed in the theory of the planet's figure, constitution, &c.

The resulting absolute dimensions of the Jovian spheroid referred to the distance 5·20 are:—

Equatorial diameter	= $37''{\cdot}646$	= 141,950 km.
Polar diameter ...	= 35·222	= 132,810 km.
Oblateness	= 1:15·53.	
Assumed mass ...	= 1:1047·35 (Newcomb).	
Density	= 1·35 (water = 1).	

"THE HEAVENS AT A GLANCE," 1902.—This handy little publication for the present year is issued in a slightly modified form. The author has repeatedly had inquiries respecting the inclusion of one or more star maps, and the present edition is furnished with two, one showing the northern stars, the other the southern objects visible from Great Britain. Another additional feature is the small map of the moon, showing the principal lunar formations.

All the more important phenomena are given for the year, and a series of summaries of the particulars relating to variable and coloured stars, nebulæ, &c.

VARIABLE STAR CATALOGUE.—In the *Astronomical Journal*, vol. xxii. No. 514, the committee appointed by the Council of the Astronomische Gesellschaft publish a further catalogue giving the elements of stars which have been certainly recognised as variable since the publication of Chandler's third catalogue (*Astronomical Journal*, vol. xvi., pp. 145–172). The present list gives the definitive designations for 191 variables, and also for the three Novæ in Perseus, Sagittarius and Aquila.

CATALOGUE OF 100 NEW DOUBLE STARS.—*Bulletin* No. 12 from the Lick Observatory comprises the fourth catalogue of new double stars having distances under 5″, discovered by W. J. Hussey with the 36-inch telescope at Mount Hamilton. (The first three catalogues appeared in the *Astronomical Journal*, Nos. 480, 485, 494.)

The search is being conducted in a systematic manner, and it is hoped that the work when more advanced will afford data for an investigation into the distribution of close double stars in various parts of the sky, and of their numbers with respect to magnitude.

THE TEACHING OF MATHEMATICS IN PUBLIC SCHOOLS.

THE following letter has been sent to the Committee appointed by the British Association to report upon the teaching of elementary mathematics.

GENTLEMEN,—At the invitation of one of your own body, we venture to address to you some remarks on the problems with which you are dealing, from the point of view of teachers in public schools.

As regards geometry, we are of opinion that the most practical direction for reform is towards a wide extension of accurate drawing and measuring in the geometry lesson. This work is found to be easy and to interest boys; while many teachers believe that it leads to a logical habit of mind more gently and naturally than does the sudden introduction of a rigid deductive system.

It is clear that room must be found for this work by some unloading elsewhere. It may be felt convenient to retain Euclid; but perhaps the amount to be memorised might be curtailed by omitting all propositions except such as may serve for landmarks. We can well dispense with many propositions in the first book. The second book, or whatever part of it we may think essential, should be postponed till it is needed for III, 35. The third book is easy and interesting; but Euclid proves several propositions whose truth is obvious to all but the most stupid and the most intellectual. These propositions should be passed over. The fourth book is a collection of pleasant problems for geometrical drawing; and, in many cases, the proofs are tedious and uninstructive. No one teaches Book V. A serious question to be settled is—how are we to introduce proportion? Euclid's treatment is perhaps perfect. But it is clear that a simple arithmetical or algebraical explanation covers everything but the case of incommensurables. Now this case of incommensurables, though in truth the general case, is tacitly passed over in every other field of elementary work. Much of the theory of similar figures is clear to intuition. The subject provides a multitude of easy exercises in arithmetic and geometrical drawing; we run the risk of making it difficult of access by guarding the approaches with this formidable theory of proportion. We wish to suggest that Euclid's theory of proportion is properly part of higher mathematics, and that it shall not in future form part of a course of elementary geometry. To sum up our position with regard to the teaching of geometry, we are of opinion—

(1) That the subject should be made arithmetical and practical by the constant use of instruments for drawing and measuring.

(2) That a substantial course of such experimental work should precede any attack upon Euclid's text.

(3) That a considerable number of Euclid's propositions should be omitted; and in particular

(4) That the second book ought to be treated slightly, and postponed till III, 35, is reached.

(5) That Euclid's treatment of proportion is unsuitable for elementary work.

Arithmetic might well be simplified by the abolition of a good many rules which are given in text-books. Elaborate exercises in vulgar fractions are dull and of doubtful utility; the same amount of time given to the use of decimals would be better spent. The contracted methods of multiplying and dividing with decimals are probably taught in most schools; when these rules are understood, there is little left to do but to apply them. Four-figure logarithms should be explained and used as soon as possible; a surprising amount of practice is needed before the pupil uses tables with confidence.

It is generally admitted that we have a duty to perform towards the metric system; this is best discharged by providing all boys with a centimetre scale and giving them exercise in verifying geometrical propositions by measurement. Perhaps we may look forward to a time when an elementary mathematical course will include at least a term's work of such easy experiments in weighing and measuring as are now carried on in many schools under the name of physics.

Probably it is right to teach square root as an arithmetical rule. It is unsatisfactory to deal with surds unless they can be evaluated, and the process of working out a square root to five places provides a telling introduction to a discourse on incommensurables; furthermore, it is very convenient to be able to assume a knowledge of square root in teaching graphs. The

same rule is needed in dealing with mean proportionals in geometry.

Cube root is harder and should be postponed until it can be studied as a particular case of Horner's method of solving equations approximately.

Passing to algebra, we find that a teacher's chief difficulty is the tendency of his pupils to use their symbols in a mechanical and unintelligent way. A boy may be able to solve equations with great readiness without having even a remote idea of the connection between the number he obtains and the equation he started from. And throughout his work he is inclined to regard algebra as a very arbitrary affair, involving the application of a number of fanciful rules to the letters of the alphabet.

If this diagnosis is accepted, we shall be led naturally to certain conclusions. It will follow that elementary work in algebra should be made to a great extent arithmetical. The pupil should be brought back continually to numerical illustrations of his work. The evaluations of complicated expressions in a, b and c may of course become wearisome; a better way of giving this very necessary practice is by the tracing of easy graphs. Such an exercise as plotting the graph $y = 2x - \frac{x^2}{4}$ provides a series of useful arithmetical examples, which have the advantage of being connected together in an interesting way. Subsequently, curve-tracing gives a valuable interpretation of the solutions of equations. Experience shows that this work is found to be easy and attractive.

With the desire of concentrating the attention of the pupil on the meaning rather than the form of his algebraical work, we shall be led to postpone certain branches of the subject to a somewhat later stage than is usual at present. Long division, the rule for H.C.F., literal equations and the like will be studied at a period when the meaning of algebra has been sufficiently inculcated by arithmetical work. Then, and not till then, will be the time to attend to questions of algebraic form.

But at no early stage can we afford to forget the danger of relapse into mechanical work. For this reason it is much to be wished that examining bodies would agree to lay less stress upon facility of manipulation in algebra. Such facility can generally be attained by practice, but probably at the price of diminished interest and injurious economy of thought. The educational value of the subject is sacrificed to the perfecting of an instrument which in most cases is not destined for use.

To come to particulars, we think that undue weight is often given to such subjects as algebraic fractions and factors. The only types of factors which crop up continually are those of $x^2 - a^2$, $x^2 \pm 2ax + a^2$, and, generally, the quadratic function of x with numerical coefficients.

In most elementary algebra books there is a chapter on theory of quadratic equations in which a good deal of attention is paid to symmetric functions of roots of quadratics. No further use is to be made of this until the analytical theory of conics is being studied. Might not the theory of quadratics be deferred until it can be dealt with in connection with that of equations of higher degree?

Indices may be treated very slightly. The interpretation of negative and fractional indices must of course precede any attempt to introduce logarithms; but when the extension of meaning is grasped, it is not necessary to spend much more time on the subject of indices; we may push on at once to the use of tables.

It will be seen that our recommendations under the head of algebra are corollaries of two or three simple guiding thoughts, the object in view being—to discourage mechanical work; the means suggested—to postpone the more abstract and formal topics and, broadly speaking, to arithmeticise the whole subject.

The omission of part of what is commonly taught will enable the pupil to study, concurrently with Euclid VI., a certain type of diluted trigonometry which is found to be within the power of every sensible boy. He will be told what is the meaning of sine, cosine, and tangent of an acute angle, and will be set to calculate these functions for a few angles by drawing and measurement. He will then be shown where to find the functions tabulated, and his subsequent work for that term will consist largely in the use of instruments, tables and common sense. A considerable choice of problems is available at once. He may solve right-angled triangles, work sums on "heights and distances," plot the graphs of functions of angles, and make some progress in the general solution of triangles by dividing the triangle into right-angled triangles. Only two trigonometrical identities should be introduced—

$$\sin^2\theta + \cos^2\theta = 1, \text{ and } \frac{\sin\theta}{\cos\theta} = \tan\theta.$$

In short, the work should be arithmetic, and not algebra.

Formal algebra cannot be postponed indefinitely; perhaps now will be the time to return to that neglected science. We might introduce here a revision course of algebra, bringing in literal equations, irrational equations, and simultaneous quadratics illustrated by graphs, partial fractions, and binomial theorem for positive integral index. Side by side with this it ought to be possible to do some easy work in mechanics. Graphical statics may be made very simple; if it is taken up at this stage, it might be well to begin with an experimental verification of the parallelogram of forces, though some teachers prefer to follow the historical order and start from machines and parallel forces. Dynamics is rather more abstract; a first course ought probably to be confined to the dynamics of rectilinear motion.

It is not necessary to discuss any later developments. The plan we have advocated will have the advantage of bringing the pupil at a comparatively early stage within view of the elements of new subjects. Even if this is effected at the sacrifice of some deftness in handing a, b and c, one may hope that the gain in interest will be a motive power of sufficient strength to carry the student over the drudgery at a later stage. Some drudgery is inevitable, if he is ultimately to make any use of mathematics. But it must be borne in mind that this will not be required of the great majority of boys at a public school.

We beg to remain, gentlemen,
Yours faithfully,

G. M. BELL, Winchester.
H. H. CHAMPION, Uppingham.
H. CRABTREE, Charterhouse.
F. W. DOBBS, Eton.
C. GODFREY, Winchester.
H. T. HOLMES, Merchant Taylors' School.
G. H. J. HURST, Eton.
C. H. JONES, Uppingham.
H. H. KEMBLE, Charterhouse.
T. KENSINGTON, Winchester.
E. M. LANGLEY, Bedford Modern School.
R. LEVETT, King Edward's School, Birmingham.
J. W. MARSHALL, Charterhouse.
L. MARSHALL, Charterhouse.
C. W. PAYNE, Merchant Taylors' School.
E. A. PRICE, Winchester.
D. S. SHORTO, Rugby.
A. W. SIDDONS, Harrow.
R. C. SLATER, Charterhouse.
H. C. STEEL, Winchester.
C. O. TUCKEY, Charterhouse.
F. J. WHIPPLE, Merchant Taylors' School.

CONFERENCE OF SCIENCE TEACHERS.

ONE of the most important of the many educational conferences which it has become customary to hold during the Christmas vacation is that arranged under the auspices of the Technical Education Board of the London County Council. The custom of inviting teachers of science from all parts of the country to attend meetings in London, to discuss the best methods of imparting instruction in the branches of science taught in schools and colleges, was inaugurated four years ago, and each successive year has seen a substantial increase in the attendance. While in 1899 fewer than a hundred teachers, inspectors and others responded to the invitation of the Technical Education Board, there were present at the meetings held on Thursday and Friday last at the South-Western Polytechnic, Chelsea, upwards of four hundred persons, among whom were representatives of every stage of science teaching.

The vice-chairman of the London Technical Education Board, Mr. T. A. Organ, presided at the first meeting and, in a speech welcoming the teachers present, referred to the neglect of science teaching in this country in the past and contrasted this with the admirable efforts made in Germany since the opening of their first chemical laboratories in 1827. As indicating the amount of leeway we have as a nation to make up, he pointed to the fact that there are nearly 10,000 more or less well-trained chemists employed in German factories, and, as half of them have undergone a complete course of several years' training in the technical high schools, it is not surprising that Germany should be gradually securing markets in which originally British trade was supreme. It is unnecessary to repeat

here the examples which Mr. Organ cited, since they have been many times referred to in NATURE. The Technical Education Board could profitably expend, said the chairman, two millions on the improvement of the provision for research in the chemical and engineering sciences alone.

Hygiene as a School Subject.

Papers were read by Miss Alice Ravenhill, on the teaching of hygiene, and by Dr. Francis Warner, on mental school hygiene. The former paper discussed several points. Can our schools be made to contribute to the work of raising the standard of health in the country? If it is desirable to teach hygiene in schools, how will the curriculum be affected by the addition of this subject? In what grades of schools should hygiene find a place, and what are the best methods of teaching it? It was rightly pointed out that hygiene is really the application to the health of the individual of most other sciences, and that instruction in physics and chemistry may very well be given a useful bias by pointing out their applications in the particular problems with which hygiene is concerned. Miss Ravenhill compared the teaching of hygiene in this country with what she had seen in the American schools during her recent visit to the States, and indicated several customs which might very well be imitated by English teachers.

Dr. Warner explained how the study of mental hygiene could be made to assist the work of the teacher. Since all mental action is expressed in movement and its results, the teacher can, by noting carefully the expression, balance and action in movement and response, of the pupil, learn much of the modes of action in the brain centres.

Natural History Teaching.

At the second meeting the chair was taken by Prof. Tilden, F.R.S., who in the course of his remarks gave it as his opinion that every educated man should possess a broad general acquaintance with the facts of biological science, and that consequently all boys and girls should have an opportunity of studying natural history. The best time for such study is probably in the holidays, for in these days of crowded school time-tables and compulsory organised games the children have no leisure hours in term time. This holiday work should not be in the hands of the ordinary school staffs, who cannot dispense with the rest of vacation weeks, but be under the care of special holiday instructors.

Addresses were delivered by Mr. F. E. Beddard, F.R.S., on the teaching of natural history, and by Prof. W. B. Bottomley, on the value of natural history collections for teaching purposes. Both speakers gave a number of reasons why natural history should be taught in schools, urging that in educative influence it is second to no subject. Mr. Beddard maintained that the teaching should be in the hands of experts, who might very well be itinerant lecturers visiting each school once or twice a week. He showed by means of a brief comparison of the horse and the donkey how natural history teaching can be conducted on research lines and so form an excellent way of training the observation and reasoning powers. He also made it clear that there need not be much expense attending the introduction of natural history into school teaching. Prof. Bottomley distinguished between natural history collections and museums; while the former are capable of assisting the teacher very much, the ordinary museum is of little value. The natural surroundings of all animals exhibited should be imitated as closely as possible, and the objects should be typical of the neighbourhood in the first place, but be supplemented by others characteristic of the great divisions of the animal kingdom.

Schemes of Nature-Study.

The principal of the University of London, Prof. A. W. Rücker, F.R.S., presided at the third meeting. Mr. R. Hedger-Wallace described American systems of nature-study. He followed the classification of the methods in common use in the United States which was recently made by Prof. Hodge, of Clark University, and gave the distinguishing characteristics of each of the eleven divisions recognised by Prof. Hodge. Most of the American schemes of nature-study are marked by an undesirable pretentiousness which teachers in this country would do well to avoid. Perhaps the best of the American methods is that of Cornell University, drawn up by Prof. Bailey, and many of the schedules and instructions issued to teachers throughout the States by the authorities of Cornell University might be copied in this country with great advantage to the teaching of nature-study in our own rural schools. Mr. Hedger-Wallace particularly condemned the sentimentality developed by much of the teaching in American schools.

Mr. D. Houston gave an eminently practical account of the plan for teaching nature-study in schools which he has worked out for the Essex County Council. In this scheme it is rightly recognised that the success of any method depends ultimately upon the equipment and enthusiasm of the instructor. Consequently great stress is, in Essex, laid upon the preparation of teachers for their work. A three years' course has been inaugurated, and in the first two of these teachers are trained by lectures and laboratory work in the branches of science which underlie any serious work in nature-study; while in the third year the student prepares a detailed monograph upon a special plant, a course which is found to give an insight into the methods of research and to help the teachers to put the children into the right attitude towards the work. Mr. Houston exhibited an interesting series of exercises performed by teachers in training and by children in schools, which showed very conclusively that the work in Essex is being done on scientific lines.

Prof. Rücker summarised the addresses and indicated the lines the subsequent discussion might profitably take. He insisted that, in the education of children, science must be brought into close connection with art and literature. Science should teach how to observe and how to reason from the observations made, but for the due expression of what has in this way been learnt a course in drawing and literature is imperative. He also pointed out that while schemes of study which have been found to work well in some schools in certain circumstances are valuable to all teachers, such courses of study must not be adopted *en bloc* by teachers. Every instructor should be continually improving his scheme of study, modifying it to meet the peculiar needs of his own classes.

During the short discussion which followed, Dr. Gladstone, F.R.S., referred to the work under the London School Board which he helped to systematise.

Technical Education in Rural Districts.

In the absence of the Countess of Warwick, Prof. H. E. Armstrong, F.R.S., presided at the concluding meeting of the conference. Mr. Hennesey, the principal of Lady Warwick's School, Bigods Hall, Dunmow, described the equipment and curriculum of his school, which he explained was a school of science in which the courses of study for rural schools drawn up by the Board of Education were adopted. The school at Bigods is attended by both boys and girls, and no disadvantages have been found to result from the plan of co-education. Mr. Hennesey explained that a difficulty is experienced when the third year is reached, since it is found that only 50 per cent. of the third-year students intend to remain in the country to take up agricultural and horticultural pursuits. Instead of making the work of the third and fourth years purely technical a compromise is effected, so that those children who will work in urban centres may not suffer. Purely technical subjects are excluded, and great care is taken to make all subjects as educative as possible. It has not been found that the general education of the pupils suffers from the agricultural bias given to the teaching.

Prof. Meldola, F.R.S., passed in review the pioneer work in secondary and technical education in rural districts which has been accomplished in Essex. He concerned himself chiefly with the difficulties which have been overcome. He said that the sporadic teaching of insufficiently educated adults which is so common in many counties does little good. The best kind of technical education is that given by experts to classes of suitably trained youths. Rural technical education will not be satisfactory until an intimate connection between the elementary and secondary school is established. At present few children from the elementary school pass on for a further period of study to the secondary school provided, like the school at Bigods, with every facility for teaching the broad principles of agricultural and horticultural practice. A thorough system of scholarships by which the best children of the elementary school could pass on to the secondary school would have excellent results.

Prof. Armstrong, in bringing the conference to a close, insisted that the success of schemes of technical instruction is in no way proportionate to the costliness of the equipment. Simple appliances are best, and workshops are more productive of good

work than elaborately fitted laboratories. Desk work must be dethroned to a large extent and the pupils be given more time in the open air.

The exhibition of home-made apparatus was not so good as usual this year. Judging from the remarks of many teachers present at the conference, this exhibition has in previous years been regarded as one of the most helpful of the items on the programme of events, and Dr. Kimmins, to whose energy the success of the conferences is due, should develop this side of the annual meetings as largely as possible in future.

A. T. SIMMONS.

A NEW RANGE-FINDER.[1]

THE instrument designed by Prof. Forbes is intended only for use with rifle fire. It is not suitable for long-range artillery, or for the Navy. This infantry type is by far the most difficult to produce, because, in addition to accuracy, extreme portability is an essential feature. At the same time, the infantry are more in need of some addition to their present resources than any one else, and the urgent need of such an instrument has been proclaimed and re-echoed by all our officers who have returned from the war in South Africa.

All methods of optically measuring the distance of an inaccessible object depend on using a base of known length, which must be measured on the ground, or else be part of the instrument. In the latter case the instrument can usually be worked by one man, who can find the distance without changing his position. This class of instrument is sometimes spoken of as short-base range-finders. Numerous patents for such instruments have been applied for; but the difficulties in the way of ensuring accuracy are so great that only one type has ever been perfected and generally used. The Barr and Stroud range-finder has been adopted by the Navy with most satisfactory results, and this has proved the fact that a short base ($4\frac{1}{2}$ feet) is not inconsistent with accuracy. For the use of infantry, however, where extreme probability, and accuracy, and suitability for ill-defined objects, such as men, bushes, rocks, &c., are essentials, this is an unsuitable instrument.

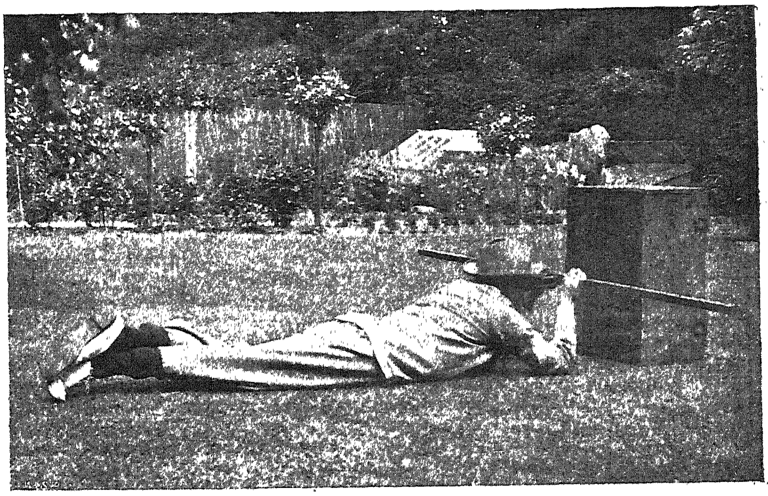


FIG. 1.—Range-Finder in use behind cover.

In the Barr and Stroud instrument the two images of a distant object are seen with one eye, hence the object appears to be double until the micrometer arrangement has been so moved as to make a coincidence of the two images, when the scale reading of the micrometer gives the distance directly. Now in naval work, for which this instrument is made, a ship, or its mast or funnel, is very sharp against the sky, and the coincidence can easily be made; but this method is almost valueless in the field. A bush, or a rock, or a man is an object so ill-defined, especially against certain backgrounds, that in attempting to make a coincidence you may move one picture in the telescope over the other for a considerable angle before you are sure that it is double. The difficulty has been got over by Messrs. Carl Zeiss and Prof. Forbes, who make use of stereoscopic vision in the new range-finder.

The instrument consists of a folding aluminium base, 6 feet in length, and a field glass. The base is a square tube hinged at its middle, and folds up to 3 feet 6 inches. Each half has at each end a doubly reflecting prism. The rays of light from a distant object strike the outer pair of these four prisms, are reflected at right angles along each tube, and are then reflected at the two middle prisms into the two telescopes of the binocular fixed to the base, in directions parallel to the original rays intercepted by the outer prisms. It is the measurement of the angle between these rays that tells the distance of the object looked at. This angle is measured by two vertical wires, one in each telescope, seen by the two eyes. One of the wires is fixed, the other is moved by a micrometer-screw until the two wires appear as one, while the object is seen distinctly. This gives the distance accurately to 2 per cent. even at 3000 yards. But now stereoscopic vision comes in and gives far greater accuracy. The wire seems to stand out solid in space, and the slightest turn of the micrometer screw causes the wire to appear to be nearer or farther than the object looked at, and when the wire appears to be at exactly the same distance the micrometer reading gives the distance with an accuracy far greater than that attainable by observing the duplication of images on the retina.

This range-finder can be used in a variety of positions. The more steadily it is held the more accurate the result. A standing position is the least steady. When kneeling, using only half the base, the other half may be bent down at right angles, and so form a leg which serves as a rest on the ground. The most easy position is sitting with the elbows resting on the knees. Another steady position is lying flat on the ground facing the object (Fig. 1). In every one of these positions you can take advantage of cover. Since the eyes are virtually at the extremities of the base, the observer may stand, sit, kneel, or lie behind a tree, bush, rock, ant-hill, horse, comrade, or waggon, and will not only be more able to work without sensation of danger, but without drawing the fire of the enemy on his comrades.

Lord Kitchener having expressed a desire to see the range-finder tested in the field, Prof. Forbes has proceeded to South Africa with his instrument, and a thorough examination of its efficiency will be made under practical conditions.

[1] Abstract of a paper read before the Society of Arts on December 18, 1901, by Prof. George Forbes, F.R.S.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

THE Prince of Wales having consented to be nominated as Chancellor of the University of Wales, has been elected to that office in succession to His Majesty the King, who has assumed the title of Protector of the University.

THE executive committee of the Carnegie Trust met at Edinburgh on Monday. The secretary and treasurer submitted their reports for the period ended December 31, 1901, showing that fees have been paid by the Trust to 2441 students, amounting to the sum of 22,941*l*. 16*s*. 6*d*. It was arranged to hold the annual meeting of the trustees in London, at which the first report of the executive will be submitted.

AT a special meeting of the Governors of University College Dundee, on January 8, Sir W. O. Dalgleish intimated that he would provide a sum of 5000*l*. for the building of the new medical school, and an additional sum of 5000*l*. towards the extinction of the debt on the College. This latter sum will be payable only if within a certain reasonable time sufficient money is subscribed to make up the remaining sum, the balance of

the debt—7500*l.*—in order that the debt of the College may be extinguished altogether.

AT a special meeting of the Court of the Victoria University, the recent movements to establish separate Universities in Liverpool, Manchester and Leeds were discussed. As the University College, Liverpool; Owens College, Manchester; and the Yorkshire College are the three constituent colleges of the Victoria University, the establishment of the three proposed Universities would mean the disruption of the present federated University. The two alternatives which the Court had to consider were as follows:—"Having regard to the resolutions of the three constituent colleges of the University, the question for decision must be whether (*a*) the three colleges are to remain as constituent colleges of the University; or whether (*b*) there should be a separate University in Liverpool and a 'University in Manchester without liability to admit or to remain in association with any other college,' and also a 'University established having its seat in Leeds.'" The latter view was accepted, and a committee was appointed to consider the terms and conditions on which it should be carried into effect.

THE New York correspondent of the *Morning Leader* says that the gifts to education in the United States in 1901 amount to more than 15,000,000*l.* Of this sum 9,000,000*l.* was contributed by three individuals. Mrs. Leland Sanford gave the magnificent sum of 6,000,000*l.* to the western University which bears her husband's name. Mr. John D. Rockefeller made an endowment of 1,000,000*l.* for the law school in the University of Chicago, and Mr. Andrew Carnegie has given 2,000,000*l.* to found an institution for scientific research at Washington. Mrs. Leland Sanford's gift of 6,000,000*l.* was in real estate and bonds and stocks. In making her gift Mrs. Sanford was actuated by the example of many wealthy persons in making bequests before their death in order to avoid possible will contests which might tie up the property for years. Mr. Carnegie's gift to endow research provides the United States with a fund which, wisely administered, will greatly strengthen university work in America and give an impetus to investigation which will have a profound influence upon the progress of the country.

THAT there is a widespread desire to modify the traditional methods of teaching the subjects of the ordinary secondary school curriculum and to bring them more into harmony with the practical needs of present everyday life, is strikingly shown by the frequent discussions on the desirability of reform in the teaching of mathematics which have taken place in the last few months. One of the most recent of such discussions was that which followed an address by Mr. W. C. Fletcher, headmaster of Liverpool Institute, at the meeting of the Incorporated Association of Headmasters held in London last week. Mr. Fletcher moved the following resolution, which was eventually adopted: "That this Association desires to press upon the universities and other examining bodies the desirability of greater elasticity in their regulations as to mathematical teaching, and is of opinion that to insist upon adherence to the order of propositions in Euclid is mischievous." Mr. Fletcher said that six years' experience of teaching geometry has led him to believe that Euclid is a great hindrance to ninety-nine boys out of every hundred in training and knowledge. A great deal of damage is done by insistence, not only upon the particular method, but on the particular order, of Euclid. As the result of his experience he had re-written the first half of Euclid's first book, omitted the second book, and introduced two or three propositions about proportion, in this way forming an interesting, sound and coherent plan. The headmasters were so impressed with the value of Mr. Fletcher's remarks that they decided to have his speech printed and circulated among teachers.

THE position of the University of Birmingham was described by the Vice-Chancellor, Mr. Chamberlain, at the second annual Court of Governors held on January 8. On the occasion of the former annual meeting the fund raised for the purpose of the University amounted to 330,000*l.*; it has now reached 420,000*l.* The Birmingham City Council has made a grant equal to a halfpenny in the pound on the borough rate, and this will provide about 5500*l.* per annum towards the ordinary maintenance of the University. The Staffordshire County Council has similarly identified itself with the aims of the University by making a grant of 500*l.* a year for five years in aid of the School of Mining and Metallurgy. It is hoped that the example will be followed by the county councils of Worcestershire, Warwickshire and Shropshire, and that the annual contributions from all these sources will amount to at least 7000*l.* per annum. With the practical assurance of this income, a sum of 300,000*l.* is available for the new buildings of the University. It is estimated that the buildings contemplated cannot be erected and equipped for a less sum than a million sterling. Out of the ten departmental blocks of the University, three are to be commenced, in the first instance, to accommodate the schools of mining and metallurgy, and of civil, mechanical and electrical engineering. A University Hall will also be erected. While the University buildings are being erected, the Mason College must be extended in some way and its equipment increased, in order to accommodate the additional students who have entered since the University was founded. For this purpose 10,000*l.* will be required, and Mr. Chamberlain announced that 6000*l.* had already been subscribed.

SCIENTIFIC SERIALS.

Annals of Mathematics (July and October, 1901).—Concerning Du Bois Reymond's two relative integrability theorems. The two theorems considered by E. H. Moore are, (1) a continuous function of (properly) integrable functions is integrable; (2) an integrable function of an integrable function is integrable. (1) was announced in 1880 and a proof published two years later (*Math. Ann.*, vols. xvi. and xx.). In connection with this proof (2) was announced. Dr. Moore in this note shows, by means of a simple example, that (2) is not true. Reference is made to a proof of (1) by Dini with an extension which is not applicable to the general case, but Dr. Moore extends Du Bois Reymond's general proof (1882).—P. Saurel, on a theorem of kinematics, gives an elementary demonstration of the well-known theorem that every displacement of a rigid body is equivalent to a rotation followed by a translation parallel to the axis of rotation.—The collineations of space which transform a non-degenerate quadric surface into itself, by Ruth G. Wood, discusses the ∞^6 collineations of space which transform the surface.—J. Westland contributes a note on multiply perfect numbers, with a view to determine all numbers of multiplicity 3 of the form $m = p_1{}^{a_1}p_2{}^{a_2}p_3$ where p_1, p_2, p_3 are three distinct primes and $p_1 < p_2 < p_3$.—The isoperimetrical problem on any surface, by J. K. Whittemore, gives a generalisation of the problem known to Pappus (see W. Thomson, "Popular Lectures and Addresses," vol. ii. p. 578). He solves Pappus's problem by the calculus of variations, and then solves, by an apparently novel method, the problem "Find a curve, $v = \phi(u)$, joining the two given points (u_0, v_0) and (u_1, v_1) having a given length L, and such that the area of the portion of the surface between the two curves, $v = f(u)$ and $v = \phi(u)$, shall be a maximum."—On a surface of the sixth order which is touched by the axes of all screws reciprocal to three given screws, by E. W. Hyde, has for its main object the determination and discussion of the envelope of a certain conicoid, which is touched by the axes of all screws of a certain system, so enabling one to grasp the nature of the system. The surface possesses other features of interest. The paper is illustrated with diagrams.—D. Sintsof, in a note sur l'évaluation d'une intégrale définie, discusses a previous note by M. Pell (evaluation of a definite integral, *Annals* (2), tome 1, No. 3).—The October number opens with a lengthy article (18 pp.) on the convergence of the continued fraction of Gauss and other continued fractions, by E. B. Van Vleck. Numerous references are given.—M. B. Porter supplies a short note on the differentiation of an infinite series term by term.—A note on geodesic circles, by J. K. Whittemore, discusses these circles in Bianchi's sense, viz. their definition is the locus of a point on a surface at a constant geodesic distance from a fixed point of the surface ("Vorlesungen über Differentialgeometrie," p. 160). Darboux ("Théorie Générale des Surfaces," vol. iii. p. 151) calls such a circle a curve of constant geodesic curvature. Mr. Whittemore gives three theorems—the first is, If, on a surface, there exists a family of concentric geodesic circles, such that the geodesic curvature of each curve of the family is constant, then the total curvature of the surface is constant along each curve of the family, and the surface is applicable to a surface of revolution, so that the geodesic circles fall on the circles of latitude of this surface.—Prof. Osgood gives a note on the functions defined by infinite series whose terms are analytic functions of a complex variable, with cor-

responding theorems for definite integrals. References to other memoirs abound.—Mr. C. L. Bouton gives an account of a game which he entitles "Nim" (a game with a complete mathematical theory). It is a game played at a number of American colleges and fairs and has been called "Fan-tan," though it does not correspond with the Chinese game of that name. He gives a description of the game (too curt, we think), and also discusses the theory of it.—Dr. G. A. Miller discusses the groups generated by two operators of order three whose product is also of order three, a short note, as is also the concluding one, on the invariants of a quadrangle under the largest subgroup, having a fixed point, of the general projective group in the plane, by W. A. Granville.

American Journal of Science, January.—An experimental investigation into the "skin" effect in electrical oscillators, by C. A. Chant. The skin effect was studied on sixteen cylindrical oscillators of various materials, including brass, iron, copper, gold, tin and silver, and of thicknesses varying from ·0000114 cm. upwards. The expected effect was not realised, as in the case of both the cylindrical and spherical oscillators the excessively thin gold shells were quite as efficient as the solid metal bodies.—The effect of hydrochloric acid upon the precipitation of cuprous sulphocyanide, by R. G. Van Name. In the presence of free hydrochloric acid the precipitation of copper sulphocyanide by a small excess of ammonium sulphocyanide is incomplete. The error can be reduced to a negligible amount by increasing the amount of the ammonium sulphocyanide.—The action of ammonium chloride upon certain silicates, by F. W. Clarke and G. Steiger. The minerals submitted to the action of the ammonium salt included stilbite, heulandite, chabazite, thomsonite, ilvaite, riebeckite, aegirite, serpentine, leuchtenbergite and phlogopite.—Studies of Eocene Mammalia in the Marsh collection, Peabody Museum, by J. L. Wortman. The present instalment deals with *Mesonyx obtusidens*.—A cosmic cycle, by F. L. Very.

SOCIETIES AND ACADEMIES.

MANCHESTER.

Literary and Philosophical Society, January 7.—Mr. Charles Bailey, president, in the chair.—The president announced that the Society was indebted to Dr. Edward Schunck, F.R.S., for a mural tablet, placed in the secretaries' room, bearing the following inscription: "This room was the laboratory of John Dalton; here his great discoveries were made, and here he conceived and worked out his atomic theory."—Mr. J. Cosmo Melvill exhibited many species of the genus Chrysanthemum, L., and described its affinities and subdivisions. He directed special attention to wild examples of *C. sinense* from China and *C. indicum* from both China and Japan, these two species being the origins of all the garden varieties, the former of the long-petalled kinds and the latter of the short-rayed and pom-pom forms.—Mr. R. S. Hutton described experiments which he had carried out at the Owens College on the fusion of quartz by means of the electric arc. He finds that, with suitable arrangement, there is no inconvenience caused by the reducing action of the arc, and that, owing to the much higher temperature, the fusion takes place with greater rapidity than with the oxy-hydrogen blowpipe. Methods were described for making tubes of quartz of any desired length in an electric arc furnace, and specimens of tubes were shown.—Dr. George Wilson read a paper on the failure of certain cast-steel dies used in the manufacture of drawn tubes. During the process of manufacturing tubes, the dies have occasionally fractured, to the danger of those using them, and an attempt has therefore been made to estimate some of the stresses to which such dies may be subjected. The results show that out of six fractured dies of which particulars were obtained, five had a factor of safety too small to cover flaws and dynamic effects. An example of the stress in a die is fully worked out, showing by curve the nature of the stresses and distortions.—Mr. C. E. Stromeyer exhibited some chemical gas washers which he had designed for dealing with relatively large volumes of gas. The largest apparatus was capable of dealing with about 50 litres per hour, and one of the smaller ones, designed to hold only six cubic centimetres of fluid and weighing only 40 grammes, was able to deal with 5 litres per hour.

PARIS.

Academy of Sciences, January 6.—M. Bouquet de la Grye in the chair.—On the focussing of a collimator or a telescope by means of the measurement of a parallax, by M. G. Lippmann. A point P at a finite distance from the collimator is viewed through an auxiliary telescope and brought on to the cross-wire of its eyepiece. The auxiliary telescope is now displaced parallel to itself through a known distance; if the image of P still remains on the cross-wire the collimator is correctly adjusted for parallel rays. If not, the collimator is adjusted until this condition is satisfied. The sensibility of the method depends on the magnifying power of the auxiliary telescope, and increases rapidly with the dimensions of the latter.—A method for verifying if a slider or a rule is rectilinear, by M. G. Lippmann.—The preparation and properties of potassium hydride, by M. Henri Moissan. The existence of a a hydride of potassium has been known for some time; in the present paper an account is given of the difficulties encountered in the preparation of this body in a pure state. Hydrogen acts very slowly at a temperature of 360° C. upon potassium, giving a white crystalline hydride of the formula KH. This is instantly decomposed by water, takes fire at the ordinary temperature in fluorine, chlorine and in dry oxygen. It possesses very energetic reducing properties, comparable to those of calcium hydride.—On a tumour of the tendon of Achilles, by M. Lannelongue. The changes in this tumour, which was not malignant, were followed by radiography. It was cured without treatment in two years, and as an operation was not necessary its exact nature remained doubtful.—The stability of a system, for any perturbations, affected by a movement of uniform rotation, by M. P. Duhem.—On the geographical position of In-Salah, an oasis of the Touatian archipelago in the Central Sahara, by M. G. B. M. Flamand. The latitude and longitude of this point, about which there has been some controversy, as well as of five other points, were redetermined by the Tidikelt expedition.—On certain systems of total differential linear equations, by M. Émile Cotton.—On the universal vibrations of matter, by M. A. Korn.—On the electrostatic field round an electric current, and on a theorem by Poynting, by M. W. de Nicolaïève. An experimental study the results of which are in exact accord with Poynting's theorem.—The general equations of electrodynamics in conductors and perfect dielectrics at rest, by M. E. Carvallo. An analytical expression and a dynamical interpretation for the two general laws of electrodynamics given in a previous paper is here deduced and the results compared with those of Maxwell.—A new method for the measurement and recording of high temperatures, by M. André Job. An application of the fact that the viscosity of a gas varies rapidly with the temperature. Oxygen gas is evolved at a constant rate from a voltameter and allowed to escape alternately through two capillary tubes, one of which is at a known temperature and the other at the high temperature to be measured. The pressure under which the gas escapes in each case is measured with a manometer, and by a direct comparison with a Le Chatelier couple it was found that the ratio of the excess of pressure in the two cases is a linear function of the temperature.—On the absolute value of the magnetic elements on January 1, 1902, by M. Th. Moureaux. The values given are for the observatory of Val-Joyeux.—The action of copper hydrate upon aqueous solutions of metallic salts, by M. A. Mailhe. The salts studied were the sulphates of cadmium, nickel, cobalt, zinc, manganese, mercury, aluminium and iron.—On the condensation of hydrocarbons of the acetylene series with esters. The synthesis of acetylenic acetones and β-ketonic ethers, by MM. Ch. Moureu and R. Delange. The reaction between the sodium derivatives of œnanthylacetylene and phenyl-acetylene with ten alkyl esters has been studied. The reaction takes place in two ways; in some cases the acyl derivative R—CO—C$\equiv$C—R′ is produced, which can be hydrolysed to the β-diketone R—CO—CH_2—CO—R′, in others the β-ketonic ester is obtained directly.—The utilisation of hexoses by the organism, by MM. Charrin and Brocard. From the point of view of utilisation by the organism, lævulose occupies the first place, galactose the second and glycose the third.—The presence of a parasite in the blood of epileptics, by M. M. Bra. Three microphotographs of the blood in epileptic patients under different conditions are given. The results appear to show that a microorganism is always present at the approach of and during the attack. This organism is a streptococcus, which would appear to have special morphological

and biological characteristics.—Contribution to the study of phosphorus as a plant food, by M. Th. Schlœsing, jun.—New observations on the evolution and origin of Peripatus, by M. E. L. Bouvier.—On the orientation of the Crinorhiza, by M. E. Topsent.—On the discovery of a nummulitic layer in a boring executed at St. Louis, Senegal, by M. G. Vasseur. From these observations the conclusion is drawn that towards the end of the lower Eocene period the sea, forming a vast gulf in the eastern portion of the Lybian desert and in the Arabian desert, and covering a part of Algeria, bent round to the north-west of the African continent and followed at a distance the line of the Atlantic coast, reaching on the south the basin of St. Louis.—Comparison of the Cretaceous basins of Eaux-Chaudes, Gèdre and Gavarnie, by M. A. Bresson.

ST. LOUIS.

Academy of Science, December 16, 1901.—A paper by Messrs. K. K. MacKenzie and B. F. Bush, entitled "The Lespedezas of Missouri," was presented by title.—Prof. F. L. Soldan delivered an address on the advance made in education during the nineteenth century, stating that the most characteristic feature of the century's progress lay in the epoch of expansion and organisation which it marked. The influence of Pestalozzi, Froebel, Horace Mann, William T. Harris and other distinguished educators was traced, the marked change in opinion concerning the commercial value of education brought out by the Centennial Exposition of 1876 was indicated, and the establishment of a true University grade in the United States with the opening of the Johns Hopkins University, the year following, was commented on.—Prof. F. E. Nipher stated that he had continued his experiments on the production of ether disturbances by explosions, and by the motion of masses of matter. He had apparently succeeded in eliminating the effects of the shock of the air-wave upon the magnet-needle. The needle is adjusted to a condition approaching maximum sensitiveness. There is no iron about the apparatus, except what is contained in the needle and in the compensating magnets. The latter are clamped in place so that the structure on which they are mounted may be pounded by a mallet without disturbing the needle. Rowland effects due to convection of electrified particles have also been eliminated. There remains a marked deflection of the needle, seeming to indicate that an ether distortion or wave originates in a sharp or violent explosion. This result is so amazing that it is announced with the statement that the whole subject is yet under the most searching examination. The coherer and the receiver of the telephone are to be used in two wholly different plans of experiment, in one of which the effects along the entire track of a leaden bullet are to be summed up in an alternating current. The results which seem to have been reached are in entire harmony with the well-known experiment of Michelson and Morley, who found that the ether within the building in which they worked was being carried along with the building and with the earth in its orbital motion.

DIARY OF SOCIETIES.

THURSDAY, JANUARY 16.

LINNEAN SOCIETY, at 8.—On the Use of Linnean Specific Names: H. and J. Groves.—Exhibitions: Branches of Cherry affected by the Gnomonia Disease, with Remarks on its Effects and Climatic Causes: A. O. Walker.—Photographs and Specimens of Heads of Wild Sheep, to Illustrate a recent Suggestion as to the Use of Large Horns in Feral Species: J. E. Harting.

CHEMICAL SOCIETY, at 8.—Myricetin, Part II.: A. G. Perkin.—The Colouring Matters of Green Ebony: A. G. Perkin and S. H. C. Briggs.—An Investigation of the Radioactive Emanation produced by Thorium Compounds, I.: E. Rutherford and F. Soddy.

FRIDAY, JANUARY 17.

ROYAL INSTITUTION, at 9.—Interference of Sound: Lord Rayleigh.

INSTITUTION OF CIVIL ENGINEERS, at 8.—The Theory of Heat-Engines: Captain H. Riall Sankey.

INSTITUTION OF MECHANICAL ENGINEERS, at 8.—Modern Machine Methods: H. F. L. Orcutt.

EPIDEMIOLOGICAL SOCIETY, at 8.30.—Dysentery in Asylums: Dr. Mott, F.R.S.—The Relation of the Dysentery of Asylums to that of South Africa: Dr. Washbourn, C.M.G.

MONDAY, JANUARY 20.

SOCIETY OF ARTS, at 8.—The Purification and Sterilisation of Water: Dr. Samuel Rideal.

TUESDAY, JANUARY 21.

ROYAL INSTITUTION, at 3.—The Cell: its Means of Offence and Defence: Prof. A. Macfadyen.

SOCIETY OF ARTS, at 8.—The Architect's Use of Enamelled Tiles: Halsey Ricardo.

ROYAL STATISTICAL SOCIETY, at 5.—Tonnage Statistics of the Decade 1891-1900: Sir John Glover.

ANTHROPOLOGICAL INSTITUTE, at 8.30.—On some Rude Stone Monuments in Yorkshire: A. L. Lewis.—On a Group of Cairns with Megalithic Cists in the West of Scotland, and the Human Remains associated therewith: Dr. T. H. Bryce.

INSTITUTION OF CIVIL ENGINEERS, at 8.—*Paper to be further discussed*: American Workshop Methods in Steel Construction: H. B. Molesworth.

WEDNESDAY, JANUARY 22.

SOCIETY OF ARTS, at 8.—Scientific Observations at High Altitudes: Rev. J. M. Bacon.

GEOLOGICAL SOCIETY, at 8.—The Fossiliferous Silurian Beds and Associated Igneous Rocks of the Clogher Head District (Co. Kerry): Prof. S. H. Reynolds and C. I. Gardiner.—A Process for the Mineral Analysis of Rocks: Prof. W. J. Sollas, F.R.S.

THURSDAY, JANUARY 23.

ROYAL SOCIETY, at 4.30.—*Probable Papers*: (1) Mathematical Contributions to the Theory of Evolution. XI. On the Influence of Natural Selection on the Variability and Correlation of Organs; (2) On the Correlation of Intellectual Ability with the Size and Shape of the Head. Preliminary Notice: Prof. K. Pearson, F.R.S.—A Short Description of the Culicidæ of India, with Descriptions of New Species of Anopheles: F. V. Theobald.—The Affinity of Tmesipteris with the Sphenophyllales: Prof. A. P. W. Thomas.—On the Excretory Organs of Amphioxus: E. S. Goodrich.

ROYAL INSTITUTION, at 3.—Recent Excavations at Delphi and in the Greek Islands: Dr. A. S. Murray.

SOCIETY OF ARTS, at 4.30.—Bengal: the Land and its People: F. H. Skrine.

INSTITUTION OF ELECTRICAL ENGINEERS, at 8.—Earth Currents derived from Distributing Systems: E. B. Wedmore.

FRIDAY, JANUARY 24.

ROYAL INSTITUTION, at 9.—The Discovery of the Future: H. G. Wells.

PHYSICAL SOCIETY, at 5.—The Factors of Heat. Part I.: James Swinburne.—Exhibition of some Twinned Crystals of Selenite: Eustace Large.

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THURSDAY, JANUARY 23, 1902.

AN "ENERGETIC" VIEW OF EXISTENCE.

Vorlesungen über Naturphilosophie. By Wilhelm Ostwald. Pp. 457. (Veit and Co., 1902.)

LEIBNITZ once remarked that if we could imagine a human brain so magnified, without disturbing the relations of its parts, that we could move about in it as "in a mill," and could learn and understand all the mechanism of brain-atoms, we should see merely atoms in motion and should learn nothing of the thoughts which correspond with these motions. Du Bois-Reymond, in an address on the limits of our knowledge of nature, expresses a similar thought. Imagining that we could acquire knowledge of the processes occurring in the brain similar to that which we possess of the heavenly bodies, he says:—"As regards the actual mental processes, it is evident that even with such an astronomical knowledge of the organ of thought (Seeles-organ) they would elude our comprehension, just as they do now. In possession of such knowledge, we should still stand before them as before something completely intangible. An astronomical knowledge of the brain, the highest we can ever attain to, reveals to us nothing but matter in motion. By no conceivable arrangement or motion of material particles can a bridge be constructed which will lead us into the region of consciousness."

"I know of no more convincing proof of the philosophic value of the application of the doctrine of energy to our method of viewing the external world," continues Ostwald, after quoting the above paragraphs, "than that in the light of that doctrine, this ancient problem loses all its terror. For the difficulties are owing to the fact that Leibnitz and Du Bois-Reymond, following Descartes, make the assumption that the physical world is constituted entirely of matter in motion. In such a world there is no place for thought. We, who regard energy as the ultimate reality, perceive nothing of such impossibilities. We have seen that the effects of nerve-conduction can be referred without contradictory ideas to energetic precursors; and we have seen, too, that nerve-processes involving consciousness are continuously connected with those in which consciousness plays no part. I have tried my best to find anything absurd or unthinkable in the assumption that certain kinds of energy involve consciousness; but I have been unable to discover anything of the kind. We shall shortly be convinced, by an investigation of the most important phenomena of consciousness, that they are conditioned by transfer of energy; and it is no more difficult for me to think that one of the conditions of kinetic energy is motion than that the energy of the central nervous system must be accompanied by consciousness."

This quotation will give the reader a glimpse into the nature of the material considered by Prof. Ostwald in these lectures. In the present review I do not intend to offer critical remarks, but merely to present to the readers of NATURE a sketch of the system of philosophy which appears to Ostwald to be the outcome of the present position of our knowledge of physical phenomena. It would be ungracious, however, not to congratulate the author on the great interest which his book awakens, and on the exceedingly clear and lucid style in which he presents his ideas, in spite of the somewhat involved constructions which the nature of the language in which it is written necessitates. In his preface Prof. Ostwald, after asking the indulgence of his readers for many imperfections and omissions, expresses the hope that in the new journal, the *Annals of the Philosophy of Nature*, the false may be corrected, the imperfect completed, and the ideas of doubtful interpretation discussed.

The earlier portions of the work deal with a critique of the older philosophical methods which attempted to forecast and explain phenomena by thinking; Ostwald sets out with the aim of controlling and regulating thought by constantly keeping phenomena in view. Yet in order to convey our thoughts to others we must make use of words and conform to certain laws of thought. In fact, we employ our intellectual apparatus to fathom the depths and investigate the working of precisely that intellectual apparatus, a problem similar to the one solved by Baron Münchausen when he extricated himself from the bog into which he had sunk by pulling himself out by his own pigtail. The ordinary methods of science, however, are here applicable; we can examine various assumptions and accept that which appears best to fulfil its purpose. We can never attain certainty, or a knowledge of the absolute, in philosophy, nor can we, indeed, in any natural science; but we may arrive at conclusions which possess a high degree of probability. And in philosophy, as in science, we must be content with a gradual approach to truth, rejecting, in many cases, conceptions found to be at variance with experience. Philosophy, like science, is empirical; but as it progresses, the region of empiricism is narrowed, although it will never ultimately disappear.

The signification of certain terms is next expounded; experience, memory, comparison, conception, thing, object; and the nature of language and the danger of mistaking words for things. A plea is here entered for the adoption of an artificial language to be used only for science and business, avoiding ambiguities and attaching definite meanings to all its words. Some words of such a language have already been adopted, as, for example, meter and gram; our musical notation and our system of ciphering are universal, and to devise a universal language would be a distinct gain for the human race. A short account of the principal parts of speech and of the changes in meaning of words concludes the chapter. The part played by our senses in receiving impressions from without is next considered, and here the particular views adopted by the author first become prominent. In every affection of the senses a *transfer of energy* has occurred. It is in receiving impressions through the tactile sense that this is most obvious, and here, too, we are impressed by the existence of a *will*. The question whether the "external world" is not to be regarded as a mere phase of consciousness or as reality is solved thus: "We have not to ask, Is there an external world? but, What phenomena must we class under the name *external world?*" "Those which are independent of my will" is the answer; or again, "Those in which my organs of sense take part."

The formation of conceptions (Begriffe) requires five operations—receiving an impression, distinguishing it from others, connecting it with others, comparing it with others and, finally, reaching a conclusion. A

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"thing" is an experience (erlebniss), generally external to ourselves, which we regard as separable or distinguishable from other experiences. But "things" are related to each other, and a collection of things forms a "manifold" or multiplicity (Mannigfaltigkeit). Ostwald illustrates the meaning of a "manifold" by the analogy of the contents of a boy's pocket; the articles have no other relation to each other than that they happen to be there. The laws of the manifolds of our experiences are represented by time and space. Time is characterised by continuity and by its being a "simple manifold," that is, from one point of time to another, there is only one path; and this implies that in time there are no points of intersection, there is only an earlier and a later, and these cannot be interchanged. Space, on the contrary, is a complex manifold, inasmuch as there is an infinite number of ways from any one point to any other, and it is "isotropic," or free from direction.

Manifolds (or collections of things in some way related) can be divided in an affinity of ways; their parts can be placed in order, and, in fact, all real manifolds must be ordered. A consideration of such order brings into operation our faculty of comparison. An instance is to be found in "ordinal" numbers, which form a manifold limited on one side, but unlimited on the other, uniform and ordered. The cardinal numbers, on the other hand, define merely the extent of a manifold, without reference to distinguishing between individuals. But ordinal numbers may be made unlimited in both directions by use of a negative sign.

The conception of magnitude next claims attention. The conceptions of identity and equality, and the impossibility of reaching certainty as regards the latter, the conditions of equality in time, the notion of continuity, and the law of interpolation lead up to the consideration of two kinds of magnitude—those which may be termed intensities or "strengths" (Stärken), and those for which the English word "capacity" or "quantity" appears the best translation (Grössen). While capacities may be subdivided into similar portions, these portions may be recombined in any proportion to reproduce a capacity of equal kind. On the other hand, intensities cannot be divided into similar portions, for each portion retains the characteristic property due to its position in the original intensity, even after subdivision. Capacities can be measured by use of cardinal numbers; thus, five litres of water remain five litres, whether they be contained in one or in a hundred vessels, whereas intensities require ordinal numbers to denote them, the first second of time is not the same as the tenth second, although it is equal to it; it is impossible to substitute the one for the other.

The restrictions of human thought by the conditions of time and space depend on the fact that while it is impossible to predict certainly what will be the consequence of any events, it is nevertheless possible to predicate what consequences are necessarily excluded. And no events in the external world are possible unless they happen in time and space. Given these conditions, however, there is an infinite possibility of events occurring. Kant's contention that space and time are "forms of thought" is considered by Ostwald to be due to our having inherited countless experiences in which these conditions of thought regarding external phenomena are essential.

And now, after 146 pages of preliminaries, we come to the features of this work which give it its definite character. Relying on the fact that in all our impressions from without the repetition of a certain individual impression at different times and seasons conveys to our minds a conviction of permanence, inasmuch as the mountains and the sea, our neighbours and ourselves, preserve identity, while exhibiting continual change, Aristotle summed up the conclusions formed by innumerable generations of his predecessors in attributing to each thing an unchangeable *substance*, its changes being ascribed to *accidental* variations. Ostwald now proceeds to inquire, What is the universal *substance?* And in what way are diverse things differentiated from each other? What is the most general *accidence* or condition of modifying substance? To this question the answer is, energy; it is the most general substance (the word being used in the signification of that which underlies all external things), for it is present in time and space, and it is also the most general accidence, for it can be differentiated in time and space. The substance of physicists and chemists is termed *matter*; but a definition of matter is avoided in most treatises on chemistry and physics. It is customary, however, to use the word "mass" in the sense of "quantity of matter." The seventy or eighty different kinds of matter are called elements. Extension, form and impenetrability are ascribed to matter, and it is regarded as indestructible. Among other properties imputed to it are inertia, weight, divisibility and porosity, but, as a rule, little emphasis is laid on the question as to which of these properties is essential and which adventitious. To the old conception of matter has been added in recent years that of ether; not, according to Ostwald, because its assumption leads to a satisfactory presentation of facts, but because people have been unable to devise any better assumption. Indestructibility, or permanence, too, has been ascribed to matter, but ponderable substances are not the only ones which possess permanence; that quality, for example, may likewise be predicated of momentum. Again, a quantity of electricity is permanent, regard being paid to positive and negative signs. Energy also possesses the quality of permanence, and it has the supreme advantage that all natural phenomena can be grouped in an orderly fashion by means of the conception of energy as an entity, and it embraces, not only the conception of substance, but also that of causality. The definition chosen for energy is "work, and all that arises from, or can be converted into, work." If the amounts of energy which result when one kind is completely converted into any other kind be termed equal, then Julius Robert Mayer's law that "during any change the total amount of the energies present remain unchanged" holds. The object of the book under review is to construct a scheme of the world by the exclusive use of the concept of energy, instead of the concept of matter.

The next chapter treats of the various forms of energy in a manner which will be familiar to those who have read Ostwald's "Allgemeine Chemie." There are here

some thoughts which appear to me new. For example, the question is asked, How comes it that all things which we know on this earth possess at once elastic energy as well as weight? The answer is, that it is conceivable that by a process of elimination all things which have no weight have left our universe; for the slightest impulse would send them on a road into space, never to return. A similar suggestion is put forward to account for the coexistence and the proportionality of mass and weight, and matter is defined in terms of energy as a portion of space in which a number of kinds of energy coexist. In reply to the question, Why do they coexist? it is answered that if they did not coexist we should be without knowledge of that portion of space; they *may be* there singly, but if so they elude our senses or methods of detection.

Ostwald claims for this method of regarding Nature that it is free from hypothesis; that each conception necessary for it has a demonstrable and measurable capacity and intensity; and that nothing is stated which cannot be tested by experiment and measurement.

It is impossible, in the limits of a review like this, to follow the author in his contest with the "mechanical explanation" of natural phenomena. An idea may be gained of his method by the quotation,

"Had our researches dealt originally with heat instead of with mechanics, we might be reading books with such titles as 'Motion Regarded as a Mode of Heat'; and there is as much justification for this title as for the ordinary version."

Indeed, the phenomena of radiation begin to be regarded as rapid alternations of conversion of electric and magnetic energies into each other, and in this the pictorial or mechanical idea is almost, though not completely, abandoned and replaced by an energetic interpretation. "Explanations," in the sense of pictorial analogies, are bound in the long run to be fallacious, and only those elements actually present in the phenomena should appear in its representation. As an illustration, it may be said that, in spite of our knowing much about the relations of bodies towards one another from an electrical standpoint, we are nevertheless ignorant of the "nature of electricity." To this it is answered that when we are acquainted with all such relations we shall know as much of the "nature of electricity" as is possible.

Among the laws of energy are to be found the following:—Every equalisation of energy requires time for its accomplishment; no equalisation (Ausgleich) can ever be complete. Only such energies can maintain themselves as distinct phenomena in space which, when coupled with others, maintain a compound equilibrium in which an increase of intensity of the one form is compensated by an equivalent increase of intensity of the other. In order that anything may take place, uncompensated differences of intensity must be present; the uncompensated excess will act as if it alone were present; the weight hung from the spring will fall, unless it is completely compensated by the tension of the spring; the spring will shorten, if the weight is not heavy enough to keep it in equilibrium.

While the happening of an *occurrence* is the resultant of differences of intensity, what we term "matter" is closely connected with capacities. The reason of this is that chemically equivalent quantities or, in other words, chemical capacities are either equal to or bear some simple relation to other capacities.

In treating of causality, Ostwald accepts Schopenhauer's view that the mind is conditioned by the necessity of ascribing a cause to all occurrences, as it must regard them as existing in time and space; but as with time and space, he regards this condition as inherited. From the point of view of energy, one form of energy is to be regarded as the cause of another kind, into which it is transformed, and it is to be noted that in such a transformation energy of higher intensity is always converted into energy of lower intensity. In the case of compensated energies, as, for instance, with a coiled spring, the cause may be regarded as the small amount of energy necessary to release or discharge it, that is, the removal of the compensation of energies at one place. Another group may be referred to a state in which the velocity of change is insignificantly small; an accelerator may be introduced, thus acting as a discharging agent. Changing his point of view, Ostwald suggests that the law of causality is nothing more than another aspect of the process of forming a concept. For this implies placing together things which display agreement in properties, and this "synthesis" may result either in the invention of a name or in the statement of a law of nature; the applicability of this concept in new cases depends only on our skill in originally forming the concept. Passing to the discussion of "necessities of thought" and applying them to the laws of logic, the question is not, Are such laws inherently necessary? but, Are our concepts in general, and among them the laws of logic, fitted to represent the sum of our experiences?

The phenomena of life next come under review. Ostwald regards as the special characteristic of living organisms self-preservation, that is, the preservation of a "stationary" form of existence; the organism must preserve its normal state by maintaining uncompensated differences of intensity by continuous expenditure of energy, and it does this by making use by its own act of previously stored supplies of energy. Reproduction is regarded as a special case of self-preservation. The stores of energy, thus utilised, are mainly chemical, and it is incidentally remarked how much more easily chemical energy can be stored than any other form. The rate of change is regulated by three methods—first, by control of temperature; second, by introducing reagents only where they are required; and third, by the use of "catalysers," that is, of substances which have the power of accelerating or of retarding chemical change. Inasmuch as time is not a factor in chemical energy, the retarding or accelerating action of catalysers requires no "explanation." It is perfectly natural to suppose that the presence of foreign bodies may exert influence as regards the rate of the conversion of chemical energy; on the other hand, if the atomic hypothesis be accepted, it is by no means evident why the motion of the atoms should suffer change by the introduction of a substance which, as it remains unchanged during the conversion of chemical energy, brings no "force" to bear capable of accelerating or retarding the supposed atomic motion.

In the chapter on the "Purpose and Means of Life"

the Darwinian theory is alluded to, and the word "fitness" (Zweckmässigkeit) is defined, with regard to life, as that which increases its duration. And "fitness" consists in the organism being provided with means for spreading, by multiplication, over a wide area, and in its possessing a large store of energy. These conditions are fully discussed in a most suggestive manner. Passing on to the nerves and their functions, it is noticed that the transfer of energy through a nerve is not dependent on the nature of the stimulus which is applied; thus a mechanical, electrical or chemical stimulus, that is, the expenditure of any one of these varieties of energy, is equally effective in causing a flow of energy through a nerve. Ostwald therefore throws out the suggestion that a special form of energy must be associated with all nerve-processes, which he terms "nerve-energy." He regards it as probable that the passage of energy in a nerve is due to the presence of catalysers, which are brought into action by the nerve-energy; these are partly destroyed by their action, so that the nerve fails to respond after it has undergone excess of stimulation. But with rest the catalysers are replaced in even greater amount than originally, and the nerve gains power by use. Organisms, in general, store energy in a chemical form, and their chief function is the conversion of this chemical energy into other forms. As a means of effecting this change they employ catalysers in order to accelerate useful changes and to retard those which are baneful. Closely connected with this idea is memory, which, according to E. Hering, may be defined as that property of living substance by means of which processes which take place in them leave effects which are favourable to the repetition of such processes. Without insisting on the justice of his suggestions, Ostwald adduces a number of chemical processes in which repetition renders the chemical change easier and more rapid.

Passing next to the consideration of the life of the soul or intellect (das geistige Leben), Ostwald takes the view that in all intellectual processes another kind of energy takes part, which he terms "spiritual" (geistige) energy. He is disposed to regard this as identical with nerve-energy, and consciousness is a property of this form of energy when its seat is the brain. Again he illustrates by an analogy; extension in space is a sign of mechanical energy and duration in time of energy of motion. Indeed, he surmises that as the processes of consciousness are themselves associated with a special kind of energy, our views of external nature are therefore legitimately energetic. One is reminded, however, of Dr. Johnson's dictum, "Who drives fat oxen must himself be fat"; at all events the idea is an ingenious one. Consciousness need not always, however, be associated with the occurrence of a process involving nerve-energy; while we have conscious impressions, conscious thoughts and conscious acts, these may also occur unconsciously. It must be admitted that some explanation is required of unconscious thought; anyhow, the author makes out a fair case for the belief.

To follow the author in his discussion of personality, of will and its freedom, of pleasure and pain, of art, of music and of goodness would occupy much space. I hope that even the very imperfect sketch which has been attempted will prove sufficient to induce students both of science and of philosophy to read for themselves this interesting work, and to examine, without prejudice, Ostwald's interpretation of the facts of Nature.

W. R.

THE CIVILISATIONS OF THE OLD AND NEW WORLDS.

The Fundamental Principles of the Old and New World Civilisations. By Zelia Nuttall. Being the second volume of the *Archaeological and Ethnological Papers of the Peabody Museum.* Pp. i+602. (Cambridge, Mass.; London: Quaritch; Leipzig: Hiersemann, 1901.)

THE interesting volume before us is, we believe, the first which any writer has devoted to a careful study of the common principles which underlie the civilisations of Egypt, Babylonia, Mexico and Europe, and as such it merits much consideration at the hands of ethnographers and anthropologists, and of students of religion in general. Much is known about European civilisation, both in its early and middle forms, and something is known of the great civilisations of Babylonia (Sumerian) and of Egypt, but Mrs. Nuttall, in bringing together the results obtained from the study of these subjects during recent years, and in putting them into line with a new group of results obtained from an examination of the Mexican inscriptions at first hand, has done a piece of good and useful work which will be appreciated by all serious students of the beliefs of primitive man. The books which have appeared in Europe and America on early symbolism and cognate subjects are many, but in most of them the writers have confounded what ought to have been kept apart, and owing to a want of groundwork of facts have been led to make nebulous theories which have earned for their authors the ridicule of the trained investigator of such subjects. There is no study more fascinating than that which results in the bringing together of the facts which are common to all great civilisations from China to Mexico, and there is probably none in which so many men have gone astray; every earnest worker knows why this has happened and deplores the publication of books and articles by faddists and others which will obscure the true light.

Mrs. Nuttall's work may be conveniently divided into three sections, which deal with the civilisations of America, Asia and Europe respectively, and these are followed by a fourth section, which treats of civilisations in general; the remainder of the book contains three appendices and an index. As was to be expected, nearly one-half of the volume is devoted to the description of American civilisation, and it is this section in which the archæologist will probably be most interested. Originally the author intended to produce a short monograph of forty-one pages, which treated of the origin of the native swastika or cross symbols, but having actually written the monograph she arrived at the conclusion that the cosmical conceptions of the ancient Mexicans were identical with those of the Zuñis. It was next clear to her that the same fundamental ideas were to be found in Yucatan, Central America and Peru, and the natural result of her investigations into them was that Mrs. Nuttall's monograph of forty pages grew into one of 284 pages, and that then she found a course of comparative studies would be necessary if the best use was to be

made of her previous labours. Unfortunately, Mrs. Nuttall began to print before she realised the magnitude of the task which she had undertaken, and it was impossible, therefore, for her to avail herself of the results of the study of symbols, &c., given by the late Mr. John O'Neil in his "Night of the Gods," by Mr. Elworthy in his work on the "Evil Eye," and by Mr. Frazer in his "Golden Bough." There is, however, little cause to regret this, for by works of this kind Mrs. Nuttall would certainly, though unconsciously, have been influenced, and it is probable that she might have been tempted to modify some of her views as the result; but as it is we have her unbiased opinions placed before us, and this is what is wanted at this stage of the study of primitive beliefs and symbolism. Many years must elapse before the final work can be written on these subjects, for all the materials upon which it must be based have not yet been collected, and until this is done it is futile to attempt to deduce the "conclusion of the matter."

Starting with the discovery that the great Mexican god Tezcatlipoca was identical with Mictlantecuhtli, and that having been overthrown by Huitzilopochtli he arose and transformed himself into the constellation of Ursa Major, Mrs. Nuttall goes on to show by a series of cuts that the constellation of Ursa Major furnished the archetype of the different forms of the swastika and cross symbols. The next point to determine was at what epoch the swastika was used as a symbol, and this Mrs. Nuttall decides could not have been before Ursa Major became circumpolar, *i.e.* about B.C. 4000.

"At that period, when Draconis was the Pole-star, the circle described about it by Ursa Major was considerably closer than it is at present" (p. 21).

At a very early period, Mrs. Nuttall thinks, Polaris came to be regarded as an immutable centre of axial energy, and in process of time as the symbol of the Creator of the universe. The rotary motion of Ursa Major was next observed carefully, and eventually the different positions of the constellation became associated with the seasons, and the swastika was commonly employed as the sign for year, or for a cycle of time.

But besides the swastika another calendar sign is known, *i.e.*, that which is a representation of the night of the winter solstice, the well-known triskelion; examples of the swastika are common among the ancient Mexicans, while of the triskelion there are none. The constellations of Ursa Major and Ursa Minor each contain seven stars, and this mystical number appears in the seven tribes of the ancient Mexicans who traced their origin to seven caves situated in the north, and in the seven parts into which Cosmos was divided. The first of Cosmos, or fixed centre, was Polaris, creative, generative and ruling power of the universe; its Four Quarters were associated with the elements and were ruled by the central force, and the ideas of Above and Below, which are found in Egyptian and other ancient languages, were suggested by the rising and setting of celestial bodies.

The Mexican religion being of a character so decidedly astronomical, it follows that everything connected with the worship of the great god would partake of the same nature; pyramids and temples were just as much astronomical observatories as houses of God, and their construction was planned accordingly. The people who held the views described above believed that they were descended from star deities, and they had a legend that the goddess "Starry Skirt," having been united to "Shining Star," gave birth to a flint knife, called Tecpatl. Their other children were startled at this, and, seizing the flint knife, hurled it to the earth, when it broke into pieces at the "Seven Caves" and produced 1600 gods and goddesses. It is worthy of note in connection with this that the flint knife was called the son of Cihuacoatl, the earth-mother. As befitted a religion which was based upon the cult of the night sky, at least one-half of the ceremonies were performed during the night; the sacred fire burnt by day and by night, and was only allowed to go out once every fifty-two years. But it was rekindled at midnight precisely.

We regret that we cannot follow Mrs. Nuttall step by step through her deductions from the Mexican picture signs and her description of primitive customs and beliefs as illustrated by them, for to do so would require the space allowed for several articles; the reader must do this for himself, and we are justified in saying that he will be rewarded for his pains if he does so. The astronomical origin of nearly every habit and custom of the ancient Mexican is clearly traced, and the relative position of the sexes in the State, as well as the classification of the people for administrative purposes, are well delineated; in short, what Mrs. Nuttall has given us is a detailed history of the ancient Mexican and his civilisation. The references to inscriptions throughout the work prove that she is familiar with what is known of the meaning of Mexican picture signs, and many of her facts are based upon the results given by Mr. Alfred Maudslay, but we are glad to see that whilst Mr. Le Plongeon is quoted at times, Mrs. Nuttall does not in any way identify herself with his wild views about the Maya language.

Passing from American to Chinese civilisation, Mrs. Nuttall has collected a large number of notes and passages from which it is seen that the Chinese held views about Ursa Major, the Four Quarters of Heaven, the Above and the Below, &c., very like those which were held by the ancient Mexicans, and it is remarkable how close is the similarity between the habits and customs and religion of the two peoples in certain respects. The really interesting point in connection with such similarity is to account for its existence; at present it is impossible to do this, and we do not see that the difficulty is in any way lightened by the theory which makes the Chinese to come originally from Babylonia, which country the emigrants are said to have abandoned when Kutir-Nakhkhunte conquered Babylon, B.C. 2295. The identity of Chinese and Akkadian has not been demonstrated to the satisfaction either of Chinese or Akkadian scholars in general, although it was fashionable some few years ago to declare that the two languages were one and the same tongue; the theory was not entertained by any except Chinese scholars who knew no Akkadian, or by men who knew a little Akkadian but had no knowledge of Chinese. The remarks on the entrance of Buddhism into China in the first century of our era are to the point, and the extracts from the famous bilingual Syriac and Chinese inscription (p. 304) at Singanfu which Mrs. Nuttall quotes contain interesting

confirmation of her views of the Christian cross being originally related to the swastika. The Chinese, taking this view, naturally called the Christians "Cross-worshippers." In Japan and India Mrs. Nuttall has found many parallels, and in Mesopotamia to this day the men of Saba appear to worship the Pole-star. The religious literature of ancient Babylonia and Assyria contains many passages which prove that the Semites who employed the cuneiform character held many views in common with the Mexicans; while an elaborate examination of Egyptian works has provided Mrs. Nuttall with a large number of proofs that in Mexico, China, and Egypt the views held in respect of certain astronomical phenomena were identical.

One of the most interesting sections of the book before us is that which treats of civilisations in general, and which contains Mrs. Nuttall's general summary and conclusions about the meaning of the facts which she has so diligently compiled. To detail these would greatly lengthen an article which is already inordinately long, and the reader will, no doubt, prefer to peruse these for himself; but we may briefly point out that the central idea of the work is that the swastika, which was first employed as a year sign, became later the symbol of the Four Quarters, of quadruplicate division, and of a stable central power, whose rule extended in four directions and controlled the entire Heaven. Human society was divided into four groups, and territorial organisations were formed in four parts. Early civilisations were founded on astronomical principles, on which also rested the worship of the gods. In the case of America, certain elements of culture are assumed to be due to "Mediterranean seafarers" and to transported refugees and would-be colonists; the basis, however, of both foreign and native civilisations was the recognition of immutable laws governing the universe, "attained, by both races, by long-continued observation of Polaris and the 'northern' constellations." The use of Mrs. Nuttall's volume is much facilitated by the excellent index, which fills thirty-four pages of matter printed in double columns in small type, and which merits great praise. We could have wished that a bibliography had been added and more references to the public literature of early symbolism; to say this is not to detract from the commendation which the book justly deserves, for a classified list of authorities could be compiled from Mrs. Nuttall's notes, and it would be useful to everybody interested in the subject.

GEOMETRY—NOT IN EUCLID'S ORDER.

Primer of Geometry, comprising the Subject-Matter of Euclid I.-IV., treated by the Methods of Pure Geometry. By H. W. Croome Smith, B.A. Pp. xvi + 100. (London: Macmillan and Co., Ltd., 1901.) Price 2*s.*

THIS little book is another attack on Euclid, and its main object is to exhibit an elementary course of geometry in a system of natural sequence—Euclid's order and method being, of course, ignored. Although in the preface the author adopts a severely logical style and successfully maintains a strong case against our conservative Euclidians, it seems to us that in one respect he is in error. His work is divided into three chapters, headed "Straight Lines and Rectilineal Figures," "The Circle," and "Areas." In the first chapter no mention of a circle occurs, and the author taxes Euclid with an illogical mode of procedure in the following words:—

"It is at least questionable logic to make use of the circle in the early stages, and subsequently to use the properties thus demonstrated of lines, angles, &c., in demonstrating the properties of the circle."

Justice to Euclid compels us to maintain that this charge is substantially unjust, because the only use made by him of the circle in the early stages (Book I. of Euclid) relies on the facts that the radius is a line of constant length, and (in prop. xii. of Book I.) that if a circle cuts a right line once, it will cut it again. No one can quarrel justly with these assumptions, or can seriously describe them as involving "properties" of the circle which require antecedent demonstration. When criticising Euclid, we must remember that geometry is not wholly a system of pure or formal logic—it implies the sense of sight, sensuous intuition in space.

One disadvantage of ignoring the circle wholly in the early stages, as is done by Mr. Croome Smith, is that we get into serious difficulties with regard to the conception and measurement of *angles*. He identifies an angle with "change in direction"—"this *change in direction*, which has nothing to do with the length of the line, is what we mean by *angular magnitude*" (p. 6); "the angle is *measured* by the amount of revolution of a straight line when turned about the vertex in the plane of the lines from the one to the other." True; but how are we to get a quantitative meaning of the word "revolution" itself? It is, without the aid of the conception of a divided circle, or of a system of superposition, just as vague and undefined as Euclid's own term "inclination." It appears to us that Mr. Croome Smith wrestles vainly with a definition of a right angle on p. 7. He imagines a right line OA to revolve round O into the position OB, which is OA reversed, and he says,

"in the position OC, midway between OA and OB in the course of its revolution, the turning line makes with OA or OB an angle which is half the preceding angle: such an angle therefore is also an angle of *constant* magnitude, and is called a right angle."

In this definition there is one little word—"midway"—the precise meaning of which we should wish to know. We fear that it is hopelessly vague without the notion of a circular protractor, or something more than the author is willing to give us. Hence we think that his definition of an angle and his method of measuring angular magnitude are not successful.

Nevertheless, criticism of this kind must not condemn a book which has several merits. A judicious teacher will always be able to supplement imperfect definitions. There is, perhaps, far too much straining after completeness of definition and verbal exactness in writers on geometry; for some of the most simple notions in the subject are things which cannot be defined with absolute accuracy, and the writer as well as the teacher must take it for granted that the pupil has already an adequate notion of the thing described—*e.g.*, a point, a right line, a plane surface.

Mr. Croome Smith rightly discards Euclid's limitation

that we must make no use of the bisector of an angle or of a line until we have shown how to draw the bisector. Fancy anyone laying down the law for Clerk Maxwell that he must make no investigation of the electromagnetic theory of light until he has demonstrated the reality of the ether! By ignoring the restriction, Mr. Croome Smith is enabled to replace the usual proof of the Asses' Bridge proposition by one much simpler.

All the *problems* of Euclid (to bisect an angle, to draw a perpendicular to a line from a point without it, to draw a tangent to a circle, &c.) are kept by themselves in a section at the end of the book. The author's proofs leave nothing to be desired on the score of simplicity, and his little book will be of much value to any committee that may be formed by the Universities or the British Association for the purpose of providing an easy and natural course of geometry for use in our schools.

We cannot refrain from calling the author's attention to the *form* of such a statement as (p. 31): "A rhombus, and therefore a square, are equilateral." This is followed by one of similar arrangement; and in line 12 from the end of p. viii, "is implied" should be "are implied."

OUR BOOK SHELF.

The Small Farm and its Management. By James Long. Pp. xvii + 281. (London: Smith, Elder and Co., 1901.) Price 6*s.*

MR. LONG starts with the idea that it is very desirable for the purpose of maintaining a vigorous rural population that the number of small farms cultivated by their owners should be considerably increased. Nearly everyone will probably agree to this proposition. When, however, we learn the conditions needed for the success of the small farmer, and which are plainly set forth by the skilful writer of the present book, we become more and more convinced that the extent to which successful farming of this kind can be developed under present conditions is very limited.

Mr. Long tells us that for a successful twenty-acre farm, third-class land must be refused at any price; that second-class land should only be occupied by highly skilled men with sufficient capital; and that first-class land should, if possible, always be selected for such a holding. The land must, further, be situated near a railway, with easy access to a large consuming population. Such land, Mr. Long frankly tells us, will generally be found already occupied, and could not be purchased save at a high price. His ideal farm is, further, to have one-half of its area in permanent grass, and to possess an acre of orchard. It must, of course, have a dwelling house and farm buildings, with a suitable access to a road. How can all these special conditions be provided except at a prohibitory cost?

When we pass to the details of the management which is to result in a handsome profit to the owner, we discover that he is supposed to be no mere agricultural labourer, but to excel both in knowledge and judgment the average farmers of the country. His farm of twenty acres is to carry one horse, four cows, a breeding flock of ten ewes, two sows and their offspring, eighty hens and forty turkeys, and is to produce for sale twenty-four quarters of oats, twelve tons of potatoes, and the fruit from an acre of orchard. His four cows are to be chosen and managed with such judgment and skill that they will yield 3000 gallons of milk every year, a quantity far above the average. His hens are to lay twice the number of eggs usual in poultry yards. Everything on the farm is assumed to be first rate and thoroughly successful. The result of this splendid management is to be a profit of 120*l.* per annum. Years of drought, or other agricultural disasters, are apparently not supposed to occur. It will naturally be asked, if a profit of 120*l.* can be made on twenty acres, why should not an annual profit of 1200*l.* be made on a farm of 200 acres worked on the same lines? And if such is the value of the land to the occupier, at what price can it be purchased?

Whatever opinions we may form as to the possibility of creating a system of small farms, or as to the prospects of their profitable cultivation, we can form but one opinion about Mr. Long's book. It is well done, and supplies a large amount of information on a great variety of subjects which cannot fail to be of value to all who are seeking to make a profit out of a small holding.

R. W.

L'Huître Perlière, Nacre et Perles. Par L. G. Seurat. ("Encyclop. Scient. des Aide-Mémoire"). Pp. 194. (Paris: Masson et Cie.) Price 2 fr. 50 c.

THIS is a useful little book of close on 200 pages and a few illustrations, in which the author—whose name was already known in connection with pearl oysters—has brought together the leading facts in regard to the molluscs, of both sea and fresh waters, producing pearl and mother-of-pearl. The introduction shows that the book has been written mainly in the interests of the French nacre industries, which the author regards as of great national importance. Although London is at present the great market for pearl shell, we are told that "La France possède, en effet, les plus vastes bancs d'huîtres perlières et nacrières qui soient au Monde, dans ses colonies d'Océanie," and the author evidently desires to stimulate the exploitation and cultivation of the French pearl industries at Tahiti and other Pacific stations. But still, the descriptions of animals and fisheries have been drawn from all parts of the world, and, in fact, most attention is given to the oyster (*Meleagrina fucata*) of Ceylon and British India on the well-known banks of the Gulf of Manaar.

M. Seurat points out on more than one page the gaps in our knowledge of the nacre-forming molluscs, and wisely insists upon the necessity of a thorough examination of the structure, life-history and habits of the Meleagrinas before it is possible to establish a rational regulation of the fisheries. The scope of the work may be gauged by the following summary of the contents of the chapters: Anatomy and biology of the pearl oyster and of other molluscs that produce pearls or nacre; the pearls, their position, structure, chemical composition and experiments as to their production artificially; the fisheries both in the sea and also in the rivers of Europe and America; commerce and industries; and, finally, pearl-oyster cultivation. In his conclusion our author sums up that "l'ostréiculture perlière est une chose possible, qui est susceptible de donner des résultats pratiques," and draws a rosy picture of the prosperity that would attend the lagoons of Tahiti under a rational exploitation of this new industry. So may it be.

Voices of Nature and Lessons from Science. By Caroline A. Martineau. Pp. 160. (London: Sunday School Association, 1901). Price 1*s.* net.

MISS MARTINEAU describes clearly a number of simple scientific facts, mainly concerning natural history subjects. She thus assists the extension of a knowledge of nature among those who are greatly in need of it. The prominence given to Darwin's teachings—a large part of the book being taken up with the elementary principles of evolution—is a very commendable characteristic. The spiritual lessons to be learnt from natural phenomena may be "skipped" by readers who prefer to deal with ethics apart from natural science.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

The Quadrantid Meteors, 1902.

ON the night of January 3 some fine meteors were observed here. It is doubtful, however, if any of them were directly connected with the radiant that has given this early January shower its name. Possibly the first meteor observed shortly before ten o'clock may have issued from the neighbourhood of Boötes, as it shot upwards from the direction of the Great Bear with a brilliancy sufficient to attract attention in a lighted thoroughfare, from where, however, its starting point could not be clearly ascertained. During a watch kept under more favourable conditions for observation, between 10.30 and 11.30 G.M.T., four or five shooting stars were observed, the brightest of which scarcely equalled a second magnitude star, its path extending from Gemini to the east of Ursa Major. The others were seen flashing to the east of the latter constellation with no well-defined centre of radiation. It should have been stated that in a ten minutes' watch between 10 and 10.30 a stationary meteor more brilliant than a first magnitude star appeared for about half a second midway between the Quadrantid radiant and Ursa Major. This was the only meteor seen that may perhaps be regarded as comformable to the radiant proper, though almost exclusive attention was given to that part of the sky. Though occasionally a look out was kept from 12 to 1 a.m., no shooting stars were seen, but in an unbroken watch from 1.15 to 1.45 a.m. a brilliant bolide was observed at 1.40 gliding down evidently from the neighbourhood of Gemini towards the Great Bear, and throwing off several fragments near the end of its path. It was the brightest meteor seen during the night. The night of the 3rd was very fine here, though a few clouds interfered somewhat with observation between 10 and 10.30.

Similar atmospheric conditions obtained in the first half of the night of the 4th, and an early watch for Quadrantids was maintained between 10 o'clock and midnight. Six or seven meteors were observed during this period. The first seen at 10 p.m. shot down through Orion at a great rate from some point considerably higher up, the exact whereabouts of which could not be known, as the meteor was only accidentally glimpsed. It must have been of a magnitude equal to Sirius. Another meteor (second magnitude) passed from a little below Gemini to Ursa Major at 10.45, and yet another from the same radiant centre to Leo at 11.45, the latter being of more than first magnitude brightness. This upper radiant must have been at the least fairly active, as the above meteors were only accidentally seen, persistent observation being maintained towards Boötes, which, however, as yet met with scant success, only a few meteors having been noticed, all below the second magnitude with the exception of one in the form of a brilliant flash, which shot straight from the direction of Boötes, but made its first appearance considerably to the east of that constellation, its course being parallel to the horizon. No definite centre of divergence could be assigned to the rest.

During a subsequent watch held between 12.45 and 1.15 there seemed to be a period of meteoric quiescence, but when the outlook was resumed at 1.30 a distinct change had evidently taken place in the interval. Bright meteors were shooting steadily from the last two stars in the tail of Ursa Major. The radiant seemed very accurately defined there at a point midway between the stars in question and very slightly to the east. From 1.30 to 1.45 five meteors issued from this centre ranging between the second and third magnitudes. During the same time also three second magnitude shooting stars came down towards Ursa Major, evidently from the upper radiant, whose activity had drawn attention to it earlier in the night, and which was now in active cooperation with the radiant centre lower down. Further observations, however, could not be obtained as regards the progress of the display, as light clouds at 1.45 a.m. began to obscure the sky, obliterating all but the brightest stars, which continued to shine dimly for a while, during which an occasional flash of a meteor was seen; but eventually the heavens became a starless blank, and the watch had to be abandoned. Whether, therefore, the radiant proper of this shower developed any symptoms of activity as the night wore on and the time of the expected maximum drew near could not be ascertained here. In view, however, of the sudden appearance of the radiant in the tail stars of Ursa Major, this may not have been improbable, the more especially as there are reasons for believing that the maximum of the shower may have occurred one or two hours later than that fixed at 3.30.

It may be observed that the multiple character of the radiant of the meteors of January 2 was particularly noticeable in 1872 (British Association Report, "Luminous Meteors," 1872), when radiant centres roughly corresponding with those on the present occasion furnished more than 50 per cent. of the meteoric shower observed in that year. JOHN R. HENRY.

Dublin.

Sir Walter Raleigh and Evolution.

I HAVE recently come across a passage in Sir Walter Raleigh's "History of the World" which seems to me sufficiently remarkable for the author to deserve a notable place among those early naturalists who anticipated in some measure the modern views on evolution. In the historical sketch at the beginning of the "Origin of Species" Darwin quotes Buffon, who was born a century and a half later than Raleigh, as "the first author who in modern times has treated the subject in a scientific spirit"; but although, scientifically, Raleigh cannot be compared with Buffon, the fact of his having penned at such an early date the words I am about to quote possesses some interest. The passage I refer to is to be found in the 1621 edition (part i., book i., chap vii., § 9, p. 94). Speaking of the days of the Flood, he says: "But it is manifest, and undoubtedly true, that many of the *Species*, which now seeme differing, and of severall kindes, were not then *in rerum natura.* For those Beasts which are of mixt natures, eyther they were not in that age, or else it was not needfull to preserve them, seeing they might be generated againe by others: as the Mules, the *Hyæna's*, and the like; the one begotten by Asses and Mares, the other by Foxes and Wolves. And whereas by discovering of strange Lands, wherein there are found divers Beasts and Birds differing in colour or stature from those of these Northerne parts; it may be supposed by a superficiall consideration, that all those which weare red and pyed Skinnes, or Feathers, are differing from those that are lesse painted, and were plaine russet or blacke; they are much mistaken that so thinke. And for my owne opinion, I find no difference, but onely in magnitude, betweene the Cat of *Europe*, and the Ownce of *India*; and even those Dogges which are become wilde in *Hispagniola*, with which the *Spaniards* used to devoure the naked *Indians*, are now changed to Wolves, and begin to destroy the breed of their Cattell, and doe also oftentimes teare asunder their owne Children. The common Crow and Rooke of *India* is full of red feathers in the drown'd and low Islands of *Caribana*; and the Black-bird and Thrush hath his feathers mixt with blacke and carnation, in the North parts of *Virginia*. The Dog-fish of *England* is the Sharke of the South Ocean: For if colour or magnitude made a difference of *Species*, then were the *Negro's*, which wee call the Blacke Mores, *non animalia rationalia*, not Men, but some kind of strange Beasts: and so the Giants of the South *America* should be of another kind, than the people of this part of the World. We also see it dayly, that the natures of Fruits are changed by transplantation, some to better, some to worse, especially with the change of Clymate. Crabs may be made good Fruit by often grafting, and the best Melons will change in a yeere or two to common Cowcummers, by being set in a barren Soyle." AGNES ROBERTSON.

The Old Hall, Newnham College, Cambridge, January 13.

The Teaching of Mathematics.

PROBABLY every experienced teacher of mathematics qualified by a sufficiently thorough acquaintance with the relations of his subject to the physical sciences and practices will have some sympathy with the document which appeared under this heading in your last issue (p. 258). I do not desire to discuss the changes it suggests, I merely wish to describe as a contrast to that or any other rational scheme the work that year by year the public purse pays some of us to attempt. Protests against South Kensington teaching and the South Kensington scheme of work are frequent, but I do not remember seeing any detailed criticism of any part of the course. Here is the work that I and hundreds more teach yearly in what is known as the second stage of mathematics.

In geometry; the second, third and fourth books of Euclid. In algebra; quadratic equations, or indeed any equation, surd or rational, for one or two unknown quantities, except such as ultimately demand the solution of a non-factorial cubic or biquadratic; the simplification of surd quantities and expressions and problems in ratio and proportion.

Trigonometry has to be taught from the beginning through the equations of identity between functions of the ratios and the values of the ratios of the simple angles to the logarithmic solution of oblique triangles, with proofs of the requisite formulæ. A sufficient knowledge of logarithms is demanded from the student to prove the ordinary logarithmic laws—no reference is made in the entire syllabus to the theory of indices—and to prove the numerical laws of characteristic and mantissa belonging to the decimal system of logarithms. He must also be able to adapt and use—for any possible logarithmic computation—a few seven-figure logarithms given at the end of his examination paper, and obtain by means of proportional differences a result corrected to six significant figures.

All this work is to be taught between September and May to pupils who, throughout the country, are generally accorded two hours a week for the subject, and who, as evening students otherwise employed through the day, are seldom able to give much time to study.

In some parts of the course—for instance, the equations set for solution—a pedant's ingenuity is used to find novelty and—for the beginner—difficulty. In other parts—as, for example, the surds and logarithms—the monotony of treatment year by year is one of the mainstays of the examination-teacher.

I have not exhausted the possible complaints against the course. Its first four stages are almost equally bad throughout, though the second is certainly the worst. But I have, I hope, said enough to convince any experienced teacher of the subject under other conditions of the urgent need we feel for changes.

I wish to guard myself against one possible personal imputation. I am not complaining because I have failed; I have been, I believe, at least averagely successful in obtaining the examination-product that South Kensington demands, and I have, I hope, also taught some mathematics. But I protest that my efforts towards the one end should be so severely handicapped by the necessity of attaining the other.

Plymouth Technical School. C. J. FORTH.

Birds Capturing Butterflies in Flight.

MR. MCKAY'S letter in NATURE of January 16 (p. 247) is of interest in pointing out that some butterflies are normally exposed in flight to danger from certain birds. Nevertheless, I believe this to be exceptional so far as this country is concerned. At the present moment I have in my possession a specimen of the day-flying moth *Orgyia antiqua*, which my friend Mr. D. F. Taylor saw seized when on the wing by a house-martin, which relinquished its hold in consequence of a luckily aimed stick from my informant. The left fore-wing shows plainly the mark of the bird's beak, which, however, did not tear the wing, but merely left a triangular area denuded of scales. So far as I am aware, house-martins do not, as a rule, feed on Lepidoptera, and this instance is probably to be regarded as a mistake on the part of the bird. It is possible that other isolated examples of similar mistakes may have been noticed, but their bearing on the general question of the coloration and markings of butterflies must be very slight. OSWALD H. LATTER.

Charterhouse, Godalming, January 17.

An Unusual Rainbow.

ON June 16 last I was at Lucerne, and at about 4 p.m. there was a remarkably brilliant rainbow over the lake. It was, however, unlike any previous rainbow ever seen by me, inasmuch as in addition to the ordinary bow of seven colours there was a second band of orange colour and a second band of purple, added to the other seven colours on the underside, but distinctly part of the same unbroken and continuous band of colour; in other words, it was a bright broad rainbow composed of nine instead of seven bands of colour. I have, since my return, met with no person able to explain this phenomenon. I was quite alone at the time. The rainbow lasted several minutes. It has been suggested to me that possibly some scientific reader of your paper could explain this very unusual appearance; or, at any rate, some other traveller at Lucerne on the day referred to may be able to confirm my description of what appeared to me so very unusual that I should almost have hesitated to accept any other person's description of it. THOMAS FULLER.

Bristol, January 17.

Change of Pitch of Sound with Distance.

IN Mr. West's letter in NATURE of December 12, 1901, he suggests that a lowering of pitch with distance may have been noticed, although his experience has been the reverse. My grandfather, the late Mr. Henry Knaüff, who, during his lifetime, was an organist and organ builder in Philadelphia, mentioned having noticed this lowering of pitch on several occasions. In long churches, with the organ over the front doorway, he claimed that the voice of the celebrant at the altar sounded distinctly flat to a listener at the organ, but on advancing to the altar this flatness disappeared. I have never noticed this myself, but I have not his ear for small differences of pitch.

PAUL R. HEYL.

Boys' High School, Reading, Penna., U.S.A.

TO THE MOUNTAINS OF THE MOON.[1]

MR. J. E. S. MOORE has undoubtedly written an interesting and original book on the lake region of Central Africa, a book which in many respects deserves to rank with that remarkable pamphlet (it was little more in volume) by the late Prof. Drummond on Nyasaland (miscalled in this instance "Central" Africa). Prof. Drummond's journeys up and down the Zambezi-Shire and the length of Lake Nyasa, with a climb on to the Nyasa-Tanganyika plateau superadded, were wholly unremarkable as a work of exploration, but Drummond contrived to see and put into pithy sentences what a legion of African explorers had seen but never expressed before. Drummond's little book should long remain a classic, and many of his expressions are quoted by the more modern African travellers with force, but without acknowledgment. Mr. Moore avows his indebtedness to Drummond on more than one occasion, but his own work is quite as original in its way, though perhaps dashed with a spitefulness which was absent from Drummond's writings. Mr. Moore's book is a true account of what he has seen, but a partial one, that is to say, he has told no untruth, but he has left untold at least a third of the whole account. In order to be original, in order to counteract the rather wearisome optimism of most works of African travel written during the last ten years, he has been careful to insist on all the faults which a white man may legitimately find with the climate, soil and insalubrity of Central Africa. He deliberately ignores much that might be permanently attractive to the European settler, much that is profitable to European commerce, and much of the good that has been done by European pioneers, whether Government officials, missionaries or traders. It is a pity in some respects that Mr. Moore's work is not complete, that he should have striven so much after originality as to refrain from writing a perfectly balanced book conveying an impartial verdict. It is, perhaps, best and fairest to regard Mr. Moore's work as a "two-thirds" book, a description giving two-thirds of the whole truth and leaving the reader to supply the missing third from the many other publications describing East-Central Africa between the White Nile and the Zambezi which have appeared since 1890. There is no doubt that Mr. Moore is eminently readable; he is so interesting that his occasional descents into sheer flippancy and his carelessness in the spelling of names may easily be forgiven, except, perhaps, by those whose names are incorrectly spelt! By a curious fatality there is scarcely a single European surname or a native place-name of any importance in the whole book which is not incorrectly spelt.

1 "To the Mountains of the Moon." By J. E. S. Moore. Pp. xvi+350. (London: Hurst and Blackett, Ltd., 1901.)

The illustrations supplied to the work consist of photographs and drawings, the latter singularly vivid if occasionally crude. Mr. Moore succeeds almost better than any other African traveller whom we know, able to use pen and brush, in giving an idea of the wonderful cloud effects to be seen in these African skies. We have stigmatised his black and white drawings as crude—as such they must appear to the ordinary European—yet in extenuation of their hard light and shade must be quoted the undeniable fact that there is something about the African atmosphere which gives these violent effects. A vivid (and the reviewer is able to say a truthful) picture is that facing p. 76—"Storm-clouds, Mountains and Bananas on the East Coast of Tanganyika."

As regards the scientific results of Mr. Moore's expedition—the point of view from which most readers of NATURE will be interested or uninterested in the book—we are able to say very little, because Mr. Moore is reserving his reports on his biological studies for another volume. The chief matters of interest to scientific students of Africa in the work under review consist of the ascent of the still active volcano of Kirunga cha gungu and a plucky attempt to ascend one of the summits of the Ruwenzori range. Interesting observations were also made on and around Lake Kivu; and Mr. Moore's opinion that this lake was probably once connected with Albert Edward and the Nile system rather than with Tanganyika and the Congo, but that the severance between Kivu and the Nile in the Albertine Rift Valley occurred through the uprising of the Mfumbiro volcanoes, is probably correct. It is certainly original. The lacustrine fauna of Kivu is apparently similar to that of Albert Edward, and quite distinct from the remarkable marine fauna of Tanganyika.

With regard to Mr. Moore's attempted ascent of the Ruwenzori range, furnished with guides by Mr. Bagge, the Government official at Fort Portal (a place which Mr. Moore persists in calling Fort Jerry), he attacked the mountain by the Mubuko Valley. According to his own account he probably reached a total altitude of 14,900 feet. Sir Harry Johnston, who ascended the mountain some months later, tells us that he, following the same route, could get no higher than 14,800 feet. Subsequently Mr. Wylde, of the Uganda Administration, also reached a point which he describes as under 15,000 feet in altitude. As Mr. Moore's and Mr. Wylde's observations were only taken by aneroid whereas Sir Harry Johnston's was by boiling-point thermometer, it is probable that all three explorers reached the same spot in total altitude, all being stopped there by the same obstacles of rocky precipices. Mr. Moore believes that the spot he reached was on the actual ridge of Ruwenzori, from which, theoretically, one might look down on the Semliki Valley or on Eastern Toro. Now from Sir Harry Johnston's observations, as given in his lecture of November 11 last, and his paper recently published in the Geographical Society's magazine, it is clear that this altitude of just under 15,000 feet is nowhere near, is

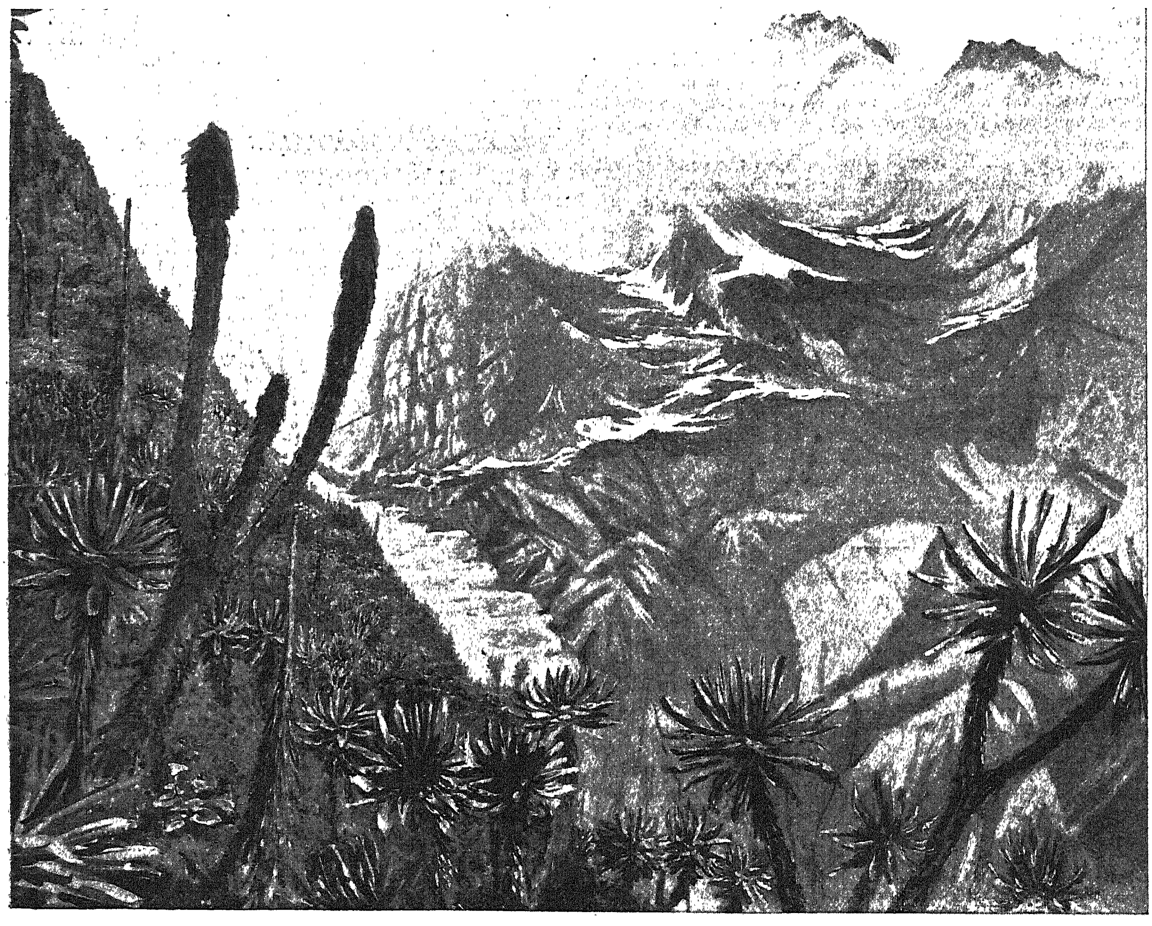


FIG. 1.—View of the small glacier between the Northern Snow Ridge of Ingomwimbi and Kanyangogwi from the former, at a height of 13,600 feet.

perhaps a couple of thousand feet below, the top of the ridge which connects all the Ruwenzori snow-peaks. Assuming this ridge to be at something like 17,000 feet in altitude, the high peaks of Ruwenzori would again rise two or three thousand feet higher, and thus the supreme altitude of 20,000 feet of the highest point of Ruwenzori which has been predicted by Major Gibbons, Sir Harry Johnston, Mr. Wylde and others is more likely to be nearer the ultimate truth than Mr. Moore's assertion that the greatest height of Ruwenzori is probably not more than 17,000 feet in total altitude.

Mr. Moore makes some very interesting remarks on the causes which probably led to the formation of the park-like scenery so characteristic of tropical Africa. On recently formed alluvial flats those strange and hideous fleshy euphorbias commence to grow on what is, to begin with, a shadeless, sandy wilderness, where all seedlings which might form forest trees are burnt up and withered by the scorching sun. The euphorbia, however, resists the sun's rays, being distinctly a plant of the desert. As its candelabra branches increase in numbers and spread out to the right and left they create shade, while the fallen branches decay and form vegetable soil. Under this protection and by this nourishment seedlings of palms and forest trees survive and flourish. When they have got a good hold on the soil the original euphorbia is long since dead or hidden, and the park-like clumps of handsome trees have become a permanent feature over what was once a wind-swept, sun-scorched, barren plain.

We strongly recommend Mr. Moore's book to the attention of all who are interested in tropical Africa. His pessimistic description, however, of the future prospects for European trade with these countries can be easily corrected by a glance at the statistics issued by the African Protectorates. Countries the trade of which has risen in a few years from an annual value of 30,000*l.* to a quarter of a million, while their local revenue has grown from nothing a year to 50,000*l.* or 60,000*l.*, cannot be such hopeless investments for European commerce and enterprise as Mr. Moore would have us believe.

Mr. Moore was accompanied on his journey by a surveyor, Mr. Malcolm Ferguson, whose surveys are certainly one of the valuable results of the expedition. If Mr. Ferguson is to be regarded as more accurate than his predecessors his work will result in the shifting of the northern end of Lake Tanganyika nearly half a degree further to the west, while he will also have supplied us with the first approximately correct delineation of Lake Albert Edward.

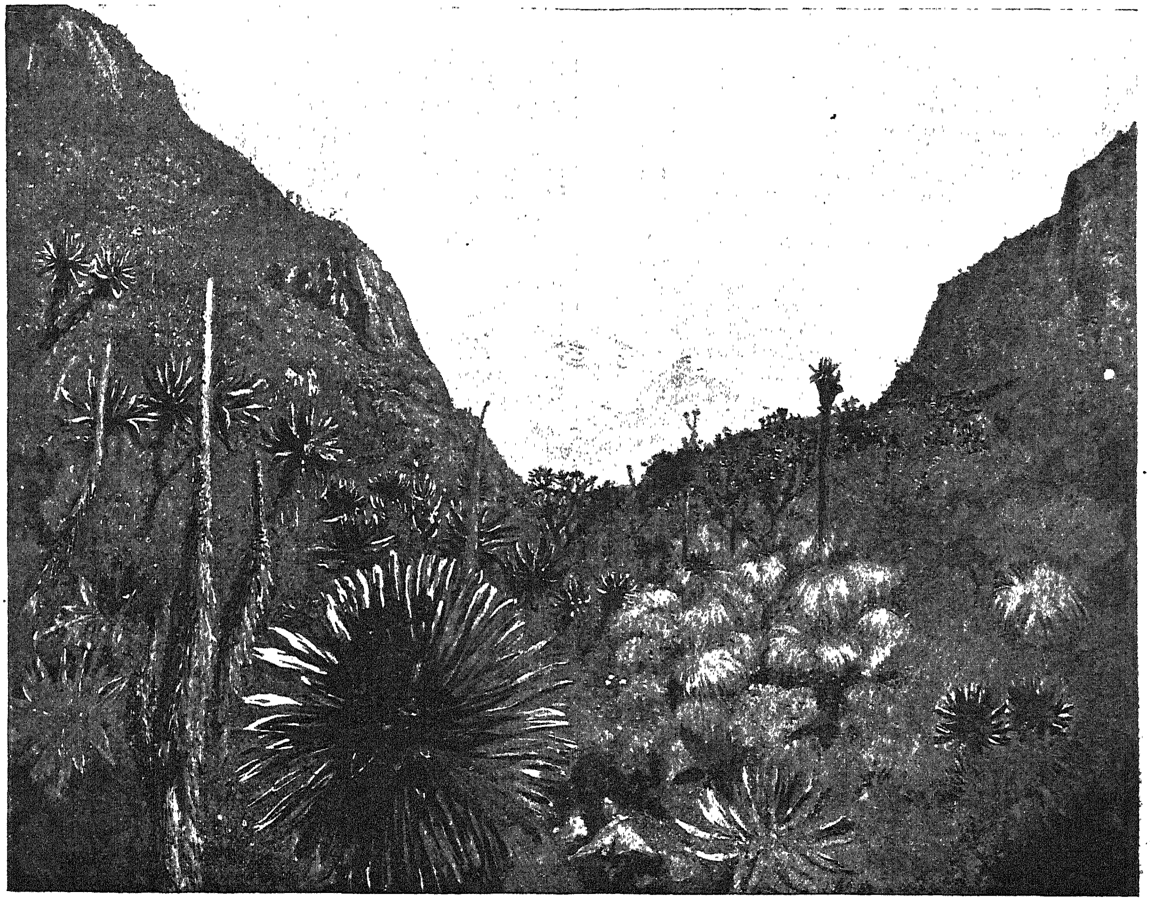


FIG. 2.—The Northern Snow Ridge of Ingomwimbi from a point about 12,500 feet.

THE RECLAMATION OF THE ZUIDERZEE.

IN a recent consular report from the Netherlands, issued by the Foreign Office, reference is made to a Bill which was introduced in the Second Chamber of the States General, for the purpose of obtaining authority to carry out the works required for the first portion of a scheme for reclaiming 800 square miles of land from the Zuiderzee, and for raising the necessary funds, estimated at eight million pounds, the cost of the entire scheme

being put at $15\frac{3}{4}$ millions. A translation of the Bill and explanatory memorandum of the Minister of the Waterstaat are also given.

This scheme for adding land to the seven provinces of the United Netherlands is only a continuation of those bloodless conquests which Holland has been carrying on for the last twenty centuries, by which, little by little, the cultivated area of the country has been enlarged without annexation, or encroachment on neighbouring countries.

Holland affords the most remarkable example of the operations of Nature in that process of destruction and reconstruction of the earth on which we live that is always in process. The land is almost entirely composed of the off scourings of Swiss, German and French territory washed off the land by the rain, transported several hundred miles by the rivers Rhine, Scheldt and Maas, and dumped by them into the North Sea, until a delta was formed and the shore advanced seaward 130 miles for a width of 60 miles. So long as the storms of the North Sea beat on this delta the fine particles of alluvium were washed away by the waves and carried to the still water of the deeper parts of the ocean, leaving only sand behind. The wind then became an active agent in the making of the land by lifting and transporting shorewards the material off the long stretch of bare sands exposed at low water, and gradually heaping it up in the form of sand hills, constituting that long line of dunes which extends the whole length of the seaboard for 230 miles and forms the main protecting barrier of the land from the incursion of the sea during storms and high tides. The delta thus sheltered and protected became one vast warping ground over which the rivers continued to deposit their burden of rich alluvium, gradually building up a soil of marvellous fertility.

Through the surface thus raised the water poured into the delta found its way to sea through innumerable channels which finally concentrated in three main openings through the dunes. The surface thus became an amphibious country, half land and half water, divided by numerous channels into islands. At the time when historical records begin some of these islands had risen above the level of the tides, and the country consisted of large alluvial plains the greater part below mean sea level, large meres or lakes from 15 to 20 feet deep, and deep winding channels, the whole bordered by the higher plains on the south and east composed of sand and drift.

At this epoch man stepped in to gather the fruits of that which the contending forces of rain and rivers, storms and tempest, wind and tides had produced.

The Roman records afford some outline of the condition of Holland at this time, from which it is known that early in the Christian era the higher diluvial lands, dunes and heaths were occupied by the Batavians, who gained a precarious living by hunting, fishing, and pasturing cattle in summer on the alluvial islands.

Whether the first embanking and reclamation was done by the Batavians or by the Romans is uncertain, but records exist showing that the latter, recognising the value of these rich lands for corn growing, commenced a system of reclamation by making more direct channels for the flood waters, and embanking the lands.

This system of reclaiming the land of the delta has gone on persistently ever since. At first only the higher lands were embanked, but as population increased the aid of science was invoked, and mechanical agency was applied to the raising of the water from the shallower meres and lakes, the motive power being the wind. For four and a half centuries the fens and morasses, lakes and old river beds which had been converted into cultivated land were kept dry by the aid of innumerable windmills studded all over the country, some of the deeper polders requiring three engines, at different levels, to raise and discharge the water. About sixty years ago steam power was added to that of the wind, being first used for the drainage of Lake Harlem, by which 45,000 acres of rich land were recovered and a new province of 10,000 inhabitants added to the country. What was once a lake from 15 to 20 feet deep is now the great market garden of Amsterdam. "And so by the skill and genius of man there was thus driven from the bosom of the country a most dangerous enemy, and a province was conquered without tears and without bloodshed, the engineer taking the place of the general and the navvy that of the soldier."

Such is the physical history of the provinces of Holland known as the United Netherlands, which has a population of nearly five millions and covers an area of 12,738 square miles, of which about two-thirds consist of reclaimed lands, intersected by a system of main drains and navigable canals extending to a length of 2050 miles. The annual budget for the maintenance of these drains and banks amounts to 500,000*l*.

The land thus obtained has, however, only been held by one long-continued struggle between man and Nature; the ocean attempting to regain the land over which it had dominion, and the rivers striving to break through the barriers that have been imposed on them, the skill and perseverance of the Dutchmen being exercised in holding that which they had gained by the most careful guarding and watching.

For nearly twenty centuries the fight has been going on, from time to time the land being attacked both from the sea and land. At different periods the rivers, resenting the limits within which their waters have been restrained, have burst their bounds and flooded the country. This has generally happened after the breaking up of some great frost, when the water, flowing down in enormous volumes, has brought with it broken ice-drifts which, blocking in some bend or other obstruction, have stopped the progress of the flood. When this occurs the water finds relief by running over the top of the banks or breaking through them, covering thousands of acres and inundating villages and homesteads. Thus in the fifteenth century the Rhine burst its banks and flooded 100,000 acres and seventy villages. In another great flood nearly the whole of Holland was inundated and 400,000 lives were lost, the country being so depopulated owing to this vast loss of life that the damage done could not be made good, or the prosperity of the country restored, for many years.

Even more disastrous than the land floods have been the breaches made in the sand-hills and sea-dykes by abnormal high tides, due to gales lasting over several days, driving the water upon the shore. It was owing to one of these great storms, at the latter end of the thirteenth century, which lasted for several days, that the water of the North Sea was raised to an unprecedented height and driven by the north-west gale on the sandbanks which protected the north coast, breaking through these in several places and inundating an enormous tract of country lying behind. By this breach the province of Friesland was separated from that of North Holland, and the water, uniting with Lake Flevo, formed the Zuiderzee, a vast inland salt-water sea 80 miles long and in places 30 miles wide. Remains of the original coast-line exist in the islands of Texel, Vlieland, Tor Schelling and Ameland. In the Zee the higher parts of the inundated land are now marked by the islands of Wieringen, Schakland, Marken and Urk, the latter of which is so little above the level of the sea that the greater part of it is covered with water whenever extraordinarily high tides occur, the houses and church standing on mounds slightly elevated above the rest of the island. Numerous villages, with their churches and homesteads, which once contained a numerous population, now lie buried beneath the waters of the Zuiderzee, and it is stated that 80,000 of the inhabitants lost their lives.

For more than six centuries the area then drowned has remained an inland sea, on which a numerous fishing

population gains its living, the plough and the waggon having given place to the net and the boat.

The reclamation of Lake Harlem having demonstrated the great advantages to be gained by such works, several schemes were subsequently brought forward for reclaiming the Zuiderzee and regaining what was thus stolen by the sea, the most extensive of these plans proposing the joining together of the islands which were left standing, and filling the gaps between them by embankments.

At last, in 1894, a Commission of twenty-seven members was appointed by the Government to make a thorough investigation of the subject, the commissioners being selected for their special capabilities for determining as to the practicability of the reclamation from an engineering point of view, and as to the cost; as to the adaptability of the land for agricultural purposes, and its value when reclaimed; as to the proper way of dealing with the interests of the fishermen who would be displaced; and generally the advantages that would occur to the State. This Commission reported in 1892, and recently a Bill was brought before the Dutch States General for carrying into effect the recommendations of the commissioners. Owing to a change in the Ministry the Bill lapsed before it had passed through the necessary stages, but there is no doubt that it will be revived in due course by the new Ministry.

The idea of entirely reclaiming the whole of the Zuiderzee by uniting the islands has been abandoned as commercially impracticable, and a modified scheme adopted for only enclosing the inner portion by an embankment 18 miles in length, extending from the North Holland coast near the island of Wieringen to the Friesland coast near Piaam. The top of this embankment will require to be 18 feet above mean high water, and it is proposed to construct in it two locks and six outfall sluices, giving a total waterway of 984 feet for the discharge of the water from the River Ysell. One of the locks is to be of sufficient size for sea-going craft, which will thus be able to get to Amsterdam through the locks at Schellingwoude and to other parts of Holland along the various canals that now have communication with the Zuiderzee. On the top will run a road and railway. The estimated cost of this bank is 3,000,000*l.* When the bank is completed it is proposed to reclaim two large areas of land on the west side which are now covered by water, containing together 131,450 acres, of which 115,000 acres will be available for cultivation, the remainder being occupied by roads, drainage canals and banks. For the drainage of these reclaimed polders eight steam pumps will be required, of an aggregate capacity of 4330 horse-power.

Subsequently it is intended to reclaim two further tracts containing 365,288 acres, but this reclamation was not included in the Bill now under consideration. When this is done there will remain a large area of water, practically the site of Lake Flevo, covering 560 square miles. It is considered that the depth of the water in this lake is too great for profitable reclamation. The cost of enclosing the two tracts of land and providing the necessary pumping machinery is estimated at 2,962,500*l.* For the interests of the fishery 375,000*l.* is allocated; for military defences, 666,000*l.*; for deepening the approaches to the harbours and other works in the interests of the navigation, 717,000*l.*, making, with the cost of the bank, a total estimated cost of 7,720,500*l.* The enclosure of the eastern polders, containing 365,288 acres of cultivatable land, is estimated at 7,862,500*l.*, making a grand total of 15,583,000*l.*

The enclosing dyke is reckoned to occupy nine years; the reclamation of the western polders would be completed at the end of fourteen years, and it would take thirty-three years before the whole reclamation could be completed.

It is proposed that the cost of the works, amounting to 7,720,500*l.*, shall be repaid by annual instalments spread over sixty years, requiring an annual charge of 166,667*l.* The renting value of the reclaimed land is estimated at 230,000*l.* a year, showing an annual financial gain of 63,333*l.*

It is considered that, even if no financial gain should ensue, the scheme is one that will be of eminent advantage in the increase in the general prosperity:—by creating a better condition of the Waterstaat over a considerable portion of the country, and in effecting a large saving in the cost at present incurred in pumping; and in the maintenance of the sea banks, the length of which will be reduced from 198 to 25 miles; by the establishment of direct communication by road and railway along the new bank between North Holland and Friesland, which will shorten the distance between Leuwarden and Amsterdam 35 miles; and, above all, by the economic advantages that will be derived from the cultivation of a very extensive tract of land, and the employment that will be given to a very large population.

W. H. WHEELER.

SMALL-POX IN LONDON.

THE statistical committee of the Metropolitan Asylums Board has recently presented an interesting report upon the cases of small-pox which have been treated by the Board during the year 1901. This report enables us to trace the growth of the present epidemic, and, so far as it goes, dealing with 1017 cases of small-pox, teaches us some very useful lessons upon a subject at the present time of the most profound interest, viz., the efficacy of vaccination as a protective measure.

It appears that in the early part of last year, in fact up to August, London was unusually free from small-pox, only slightly more than a dozen cases having occurred. From August 22 and on, however, the disease appeared to have obtained a strong hold in the parishes of St. Marylebone and St. Pancras. Subsequently cases occurred in every one of the thirty-one poor-law parishes and unions comprising the Metropolitan Asylum District. The average weekly admissions were as follows:—In August, 35·5, September, 37·75; October, 39·75; November, 113·6; December 1 to 28, 164·5; December 28 to January 4, 242·0.

With regard to gross mortality, this is given at 24·28 per cent. It must, however, be borne in mind that in arriving at this figure many cases of recent admissions have been included because they have already been completed by death, whereas the contemporary cases, which will probably nearly all recover ultimately, cannot be included until completed by discharge. The result is that the rate of mortality above must be admitted to be undoubtedly higher than it will be when all the cases have been completed and the final rate ascertained.

For the purpose of estimating the effect of vaccination upon the cases which have died or recovered during the year, these were divided into three classes: (1) cases with visible cicatrices, (2) doubtful cases, (3) unvaccinated cases. The total mortality rate per cent. of vaccinated cases was 14·21; of doubtful cases 65·08; of unvaccinated cases 50·52. It strikes one at first as odd that the mortality of the doubtful cases was ten per cent. higher than that of the admittedly unvaccinated. By definition it, however, appears that the doubtful cases most probably consisted of practically unvaccinated cases, and were very few in number. Perhaps one of the most marked features in these statistics is the protection from small-pox afforded by successful infantile vaccination. Under ten years of age only twelve vaccinated cases are recorded and no death. Infantile vaccination, further, seemed greatly to diminish the rate of mortality from the disease even up to forty, although there was a very rapid

falling off of its power in this direction after twenty years of age.

With regard to the value of and necessity for re-vaccination, the experience of the committee confirms that of a similar committee which reported upon the small-pox epidemic of 1870-72. "No greater argument to prove the efficacy of this precaution," says this report, "can be adduced than the fact that out of upwards of 14,000 cases received into the hospitals only four well-authenticated ones were treated, in which revaccination had been properly performed, and these were slight attacks."

NOTES.

THE work of preparing Bushy House for the National Physical Laboratory is now approaching completion, and, His Royal Highness the Prince of Wales has fixed Wednesday, March 19, for the opening ceremony. The object of the Laboratory is to encourage the applications of physical science to manufactures and industry. This it will do by undertaking researches into questions of importance to either, and by testing apparatus and material used in trade.

PROF. J. W. GREGORY, F.R.S., has been temporarily appointed head of the Geological Survey of Victoria, with a view to its complete reorganisation and the substitution of a staff engaged on a permanent basis instead of the present temporary plan. The Victorian Government is paying for extra assistance in the geological department of the University while Prof. Gregory is engaged upon this work.

AN expedition to Lake Eyre, the great depression in Central Australia sinking below sea-level, has recently left Melbourne. The party consists of Prof. J. W. Gregory, his assistant, Mr. H. J. Grayson, and five students of the geological department of the Melbourne University. The main objects of the expedition are the study of the physical history of the Lake Eyre basin and the collection of fossils, especially the extinct giant vertebrates. The camel caravan starts from Hergott Springs, a station 440 miles north of Adelaide. It is hoped that the collections will throw light on some unexplained native traditions as to former giant animals that inhabited the Lake Eyre basin.

THE annual congress of the Sanitary Institute will be held in Manchester on September 9–13, when Earl Egerton of Tatton will preside. Section I. (Sanitary Science and Preventive Medicine) will be presided over by Sir J. Crichton Browne, F.R.S.; Section II. (Engineering and Architecture) by Sir Alexander Binnie; and Section III. (Physics, Chemistry and Biology) by Prof. A. Sheridan Delpéine. Eight technical conferences will also be held in connection with the congress.

IN the House of Commons on Monday, in reply to Mr. Field, who asked a question in regard to the proposed erection of a suitable College of Science in Dublin, Mr. Austen Chamberlain said:—"Thirteen thousand pounds was voted in 1899–1900 and applied towards the purchase of part of the site for a new college. I hope shortly to introduce a Bill for the acquisition of the rest of the site, for the provision of funds for the new building, and other purposes. I have satisfied myself by personal inspection of the existing college that that building is quite inadequate to the work which it is intended to perform."

THE American Society of Naturalists held a successful meeting at Chicago at the commencement of this month. There was a discussion on the relation of the Society to other scientific societies, an address by the president, Prof. Sedgwick, on the modern subjection of science and education to propaganda, dealing largely with attempts to prevent the experimental study of physiology, a lecture by Dr. Howard on international work with beneficial insects, and 244 papers on scientific subjects. The society will meet next winter at Washington, in conjunction with the American Association for the Advancement of Science. A committee was appointed to confer with a similar committee to be appointed by the naturalists of the central and western States in regard to the relations of the two societies. At the meeting to be held next year the president will be Prof. J. McKeen Cattell, and the vice-presidents Messrs. C. D. Wolcott, L. O. Howard and D. P. Penhallow.

WE learn from *Science* that Mr. Andrew Carnegie's gift of ten million dollars for scientific research has been transferred to a corporation to be known as "The Carnegie Institution." The original incorporators include Dr. D. C. Gilman, lately president of Johns Hopkins University, the Hon. Chas. D. Walcott, Director of the U.S. Geological Survey, Dr. John S. Billings, and the Hon. Edward D. White. The objects of the Institution, in addition to the promotion of research, are set forth as follows:—To acquire, hold and convey real estate and other property necessary for the purpose of the Institution and to establish general and specific funds. To conduct, endow and assist investigation in any department of scientific literature or art, and to this end to cooperate with Governments, universities, colleges, technical schools, learned societies and individuals. To appoint committees of experts to direct special lines of research. To publish and distribute documents, to conduct lectures and to hold meetings. To acquire and maintain a library and, in general, to do and perform all things necessary to promote the objects of the Institution.

ON January 17 Lord Rayleigh opened this season's Friday evening meetings at the Royal Institution with a discourse on the interference of sound. In the course of his remarks he described some of his recent experiments with fog-horns, made for Trinity House. Fog-horns with elliptic cones instead of circular ones were tried, the major axis being about four times longer than the minor one. The experiments showed that the sound was best spread in a horizontal direction when the long axis was exactly vertical. It appears to be doubtful whether the phenomenon of the silent area is really due to interference between waves of sound reaching the spot direct and those reflected from the sea. If the effect were merely due to interference in this way, it ought to be possible to recover the sound by the listener changing his altitude above the sea surface, but Lord Rayleigh has on several occasions tried this on board the *Irene* and has not recovered the sound. When two or more fog-horns are used at one station, it sometimes happens that owing to the different sound waves being out of phase they more or less neutralise one another at certain distances, so that one source of sound is sometimes better than several. At the close of Lord Rayleigh's discourse, the Duke of Northumberland, as president of the Institution, unveiled a bust of Sir Frederick Bramwell, formerly honorary secretary of the Institution, and formally presented it to the members on behalf of the managers and their friends as a token of esteem.

THE death is announced of Prof. H. von Ziemssen, professor of pathology and therapeutics in the University of Munich.

COMMISSARY-GENERAL G. D. LARDNER, whose death at the age of eighty-four we regret to see announced, was the eldest son of the renowned Dr. Dionysius Lardner, and, like his father, he did much to encourage the study of astronomy, though his writings and lessons did not reach so large a public. He was a Fellow of the Royal Astronomical Society, and devoted his

leisure hours to scientific pursuits and to inspiring interest in natural knowledge in others. The death of such a man is a real loss to science.

ANNOUNCEMENT has already been made of the death, on December 24, 1901, of Mr. Clarence King, who for a short time was Director of the Geological Survey of the United States. His most important work was in connection with the geological exploration of the fortieth parallel, of which the main portion, published during the years 1876 and 1877, comprised various reports and the geological and topographical atlas of the Rocky Mountains, the Green River and Utah Basins, and the Nevada Plateau and Basin. At this date there were two other important geological surveys in the States apart from various local surveys; thus G. M. Wheeler was directing the surveys west of the 100th meridian, and F. V. Hayden was in charge of the Survey of the Territories. The three main surveys were consolidated in 1880 as the United States Geological Survey, under the directorship of Mr. King. Coming to the work from a long and successful experience, he elaborated a comprehensive plan of operations, and vigorously prosecuted the same through the assistance of a wisely selected corps of geologists and specialists. He directed investigations on Leadville in Colorado, on the Eureka district, and on the Comstock lode in Nevada. Mr. King, however, held office for a year only, retiring in 1881, as he believed he could render more important service to science as an independent investigator. He was succeeded by Major J. W. Powell, from whose introductory remarks in the second annual report of the United States Geological Survey we gather some of the above particulars. The hope entertained by Mr. King was not fulfilled, as unquestionably his most valuable contributions to science were his official maps and reports. In later years his most important paper was that on the age of the earth, which appeared in the annual report of the Smithsonian Institution for 1893.

SOME of the scientific results obtained by members of the National Antarctic Expedition during the voyage of the *Discovery* from the Cape to New Zealand are mentioned in an article in last Saturday's *Times*. It was part of the instructions of the expedition that the *Discovery* should proceed southwards towards the point of maximum total magnetic force. The despatches received state that on November 12, 1901, in latitude 50° S., longitude 131° E., Captain Scott determined to turn southwards towards this focus, running more or less on the line of no variation. The result was a very gradual increase of total force, while there were other points of interest in the observations of the dip and variation. The *Discovery* continued to push southwards till November 16, when the first ice was sighted. The detached pieces which were first met with were soon succeeded by a loose pack of drift ice, with occasional fragments of glaciers. On November 16 a sounding was taken in 2300 fathoms, while the magnetic observations showed a dip of 86°. The furthest south point reached was 62° 50′, in longitude 139° 40′ E. The highest glacier was seen on November 17, when another sounding was made in 2300 fathoms. The *Discovery* turned north-eastwards on November 17, and on the 18th a sounding was made in 1750 fathoms. Captain Scott then made as rapidly as possible for his destination in New Zealand. On November 22 Macquarie Island was reached. A landing was effected, and the naturalists did some good work. Auckland Island was sighted on November 25, and Lyttelton was reached on November 28. As already announced, the *Discovery* has since then turned her face southwards to enter upon the real work of the expedition. In order that the expedition may be in a position to complete the work for which it has been organised, it is essential that it should be free to remain away for at least two, and if possible three, years, as is the case with the cooperating German expedition. For this end more funds are absolutely necessary (1) to supplement the equipment of the main expedition, and (2) to send out a second ship in the autumn of 1902. The second ship is indispensable if the expedition is not to return after one year's work. It is required to take out a further supply of coal and other stores, to bring away any members of the expedition who may be incapacitated, and to leave suitable substitutes, as well as to obtain information as to the further plans of the expedition. About 6000*l.* has been subscribed for this purpose, and at least 10,000*l.* more is required in order to equip and man the ship which has been obtained. The urgency of the need should inspire those who have the means to come forward with liberal offers of assistance.

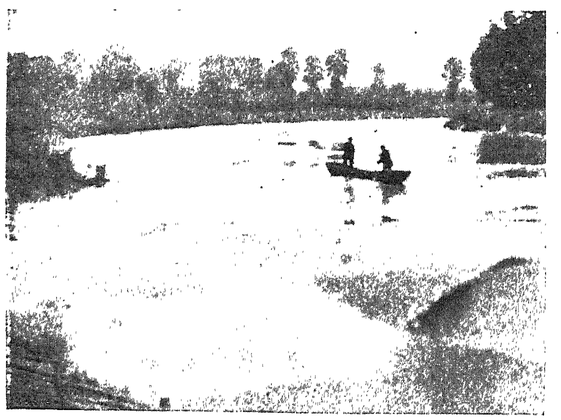
A PAPER on modern machine methods, by Mr. H. F. L. Orcutt, read at the Institution of Mechanical Engineers on Friday last, contains a large amount of information in illustration of the value of perfected methods of machining. The use of accurate limit gauges instead of measuring with micrometers or calipers is strongly urged, even in small shops. There is a widely spread and erroneous idea, particularly amongst European manufacturers who would emulate American manufacturers, that the latest methods cannot be economically adopted except where work is thoroughly standardised, specialised, and made in large quantities. Mr. Orcutt thinks otherwise, and remarks that a single hole is more cheaply bored in a chucking machine than in a lathe. It is more easily made to a limit gauge than when the skill of a workman in setting his calipers has to be trusted. One spindle is more cheaply finished in the grinding machine than in the lathe, quality duly considered, and, again, is more easily finished to a limit gauge than to calipers, with the employment of less skilful labour. The idea that big quantities and standard work are necessary before modern equipment begins to play an important part in the economics of manufacturing, is described as the delusion of those who have grasped but a small part of the problem. The advantages of possessing a well-equipped laboratory and testing department are pointed out. Materials should be studied with a view to selecting that which is most suitable for the purpose, which, being most suitable, can be most rapidly machined, and which, fulfilling all conditions, is the cheapest. This cannot be accomplished with the haphazard methods commonly employed. Where the size of a shop does not warrant the expenditure necessary to support its own department, several manufacturers ought to combine and contribute to the support of a fully equipped laboratory. There is, however, Mr. Orcutt states, no practical reason why every mechanical engineering establishment in the United Kingdom should not have a testing institution at its command which could be constantly in use. The realisation of this state of affairs would be of incalculable benefit to the industries and commerce of Great Britain.

THE report of the proceedings of the fifth Congress on Criminal Anthropology has just been issued. Prof. G. A. van Hamel, the president, briefly described, in his opening speech, the scope of anthropology so far as it is concerned with criminology. Prof. Lombroso gave the Congress a comprehensive sketch of the progress of anthropological research since 1897, and read a paper on the prevention and treatment of crime. He was of opinion that the passions which inspire many serious crimes, especially those committed from political motives, were energies which might be turned to the advantage of the community if only they were classified and directed into the proper channels. Profs. Lacassagnes and Martin, adopting as their text *les sociétés ont les criminels qu'elles méritent*, contended that the only way to stamp out *recidivistes* and habitual criminals was to enact drastic laws to limit the consumption of alcohol,

and to provide against the dissemination of tuberculosis and venereal disease. Dr. Garnier, of Paris, stated that juvenile crime, which was rapidly increasing, was the result of the prevalence of alcoholism. Mr. Alexander Sutherland, of Melbourne, suggested that too much importance ought not to be attached to the theory of heredity, so far as it applied to crime, and pointed out that while in 1850 the population of Australia was composed of 135,000 individuals who were either convicts, or the children of convicts, and of only 105,000 normal persons, in 1880, after the course of but one generation, the number of criminals in Australia per 10,000 of the population was much below that in Prussia, Saxony, Italy and Sweden.

IN the *Scientific American* for January 4, Mr. L. P. Gratacap gives a popular and illustrated description of the discovery and preservation of the remains of the great dinosaur, brontosaurus, which have recently been placed in the Natural History Museum, New York. It was in 1898, under the direction of Prof. Osborn, that the colossal vertebræ, ribs and pelvic bone of the dinosaur were obtained from the Jurassic limestones of Wyoming. The total length of the animal has been estimated at more than sixty feet. The bones were taken out *en bloc* in the field, retained in the enveloping matrix, and shipped to New York, where a corps of skilled workmen finally extracted them from the stony matrix in the most perfect condition.

THE accompanying illustration of the Severn Bore is reproduced from a portion of the kinematograph picture recently obtained under Dr. Vaughan Cornish's direction with a bio-



scope camera and exhibited at the Royal Geographical Society. When first projected on the screen the Severn is seen at low water; in a few seconds the bore appears round the bend of the river about 500 yards distant, and it takes rather more than one minute to arrive at the position shown in the illustration. It is only upon reaching the shoal water near the camera that the wave curls over as here shown. The dark-fronted wave then rushes out of the field of view and the remainder of the film records the rapid current which follows close upon the bore. The film is 150 feet long with 2400 pictures, about half of which are views of the bore itself. The moving picture not only enables those who have never seen a tidal bore to realise the phenomenon with a completeness impossible from the examination of stationary photographs, but it provides a means for exhibiting at will a phenomenon which in nature is never precisely repeated. By repeating the projection of the picture as often as required, the various aspects of the phenomenon can be successively studied in a manner impossible to the observer of the bore itself. How much escapes observation when watching a transitory phenomenon, and the advantage of repeated projection on a screen, may be gathered from the various accounts which different spectators give of a kinematograph picture which all have seen simultaneously, but in which the points of attraction and interest are different in the case of different individuals.

SIR CHARLES TODD, K.C.M.G., F.R.S., has recently issued his comprehensive volume of meteorological observations in South Australia, for 1898. The work is divided into three parts; sections 1 and 2 deal with the observations at Adelaide and a number of other stations, and contain a valuable discussion on the exposure of thermometers in different screens. Section 3 gives the monthly and yearly totals of rainfall at 432 stations, and comparisons of the results with the averages for previous years. The annual distribution of rainfall is also clearly shown on a tinted map.

MR. J. E. CLARK has contributed an interesting paper to *Symons's Meteorological Magazine* for this month, entitled "Day Darkness in the City." He has recorded the number of quarter hours at which artificial light was necessary between 9h. a.m. and 5h. p.m. (Saturday afternoons and Sundays excepted) at the Wool Exchange, between October and March, 1897–1901. The tables show that November, December and January are preeminently the dark months, although, on the mean, November is a good deal behind the other two. The only really bad foggy months in the four years were December 1899 and January 1901, with which may be compared the prevalent fogs of November and December last. A diagram showing the distribution of dark quarter hours during the day shows a rapid rise between 9h. and 10h. and again about noon. The author points out that these anomalies are associated with the lighting of office fires and with preparations in the restaurants; in fact, smoke plays a main part in the darkness during both high and low fogs.

IN the *Bibliotheca mathematica* (iii. 2) for December 30, 1901, Prof. Gino Loria, of Genoa, gives an account of the late Prof. Beltrami, with a fairly detailed statement of the mathematical theorems and formulæ discovered by him. The paper is illustrated by a portrait of Beltrami.

SOME observations on the variation of position of the apparent horizon relative to the true horizon on the lake of Geneva are described by Prof. F. A. Forel, of Morges, in the *Comptes rendus de la Société helvétique* for the Neuchatel meeting of 1899, recently received. The extreme relative displacements of the horizons, due to refraction, during eight months' observation varied from $-272''$ to $+501''$, the telescope being 2·5 metres above the lake. A table is given of corrections for refraction in terms of the difference of temperature at the surface of the lake and at the altitude of observation.

A SHORT paper on the observatory of the University of Durham is given by Prof. R. A. Sampson in the *Proceedings* of the Durham Philosophical Society. The observatory was built in 1840, and the chief event in its annals was the tenure of the post of observer by Richard Carrington, which, however, he resigned in 1852, after holding it for three years. From that time on the observatory seems to have had a chequered career until 1891, when the old equatorial was replaced by a new one. In 1896 a new departure was made; instead of the transit circle being renewed an almucantar was provided, and with this it is hoped to do rather better work than could be expected with a meridian instrument.

WE are glad to learn that the gliding experiments with which Lilienthal and Pilcher sought to investigate the balance and stability of machines supported by aëroplanes and aërocurves have not been discontinued since the death of these two investigators. A great deal of valuable work has already been done in America by Mr. Octave Chanute, and in conjunction with him

by Mr. Herring, both of whom have attained results in advance of those previously achieved, by the use of machines provided with movable wings. Still more recently, *i.e.* from October 1900 onwards, two other workers have attacked the problem, namely, Mr. Wilbur Wright and Mr. Orville Wright, of Dayton, Ohio. Mr. Wilbur Wright adopts a two-surfaced machine and assumes a horizontal position when gliding, with the view of diminishing head resistance. He has successfully worked with a surface area of double that used by previous experimenters, and has on several occasions extricated himself from the dangerous position in which Lilienthal and other observers have found themselves when suddenly brought to rest in a high wind.

PROF. V. MONTI has forwarded us three papers dealing with the question of prevention of hailstorms, which is now exciting so much interest in Italy. One of these, published by the Italian Meteorological Office, deals generally with the distribution of hailstorms in Italy at different seasons. Prof. Monti divides Italy roughly into three different regions, the "Padan" region, including the valley of the Po and certain Alpine stations, where hailstorms commence between the end of February and May and cease about November; the "Peninsular" region, where no month is altogether exempt from hail; and the "Calabro-Sicilian" region, which is characterised by an almost complete absence of hailstorms during the summer months. A second paper deals with the question of whether hailstorms are affected by the detonations accompanying volcanic eruptions. In it Prof. Monti discusses an account of a hailstorm on Stromboli, by M. Brun, of Geneva, and other writers, and he infers that (1) the fall of hail is not prevented by volcanic detonations; (2) hail may even be formed in storms of volcanic origin, contrary to Faye's theory. In the third paper Prof. Monti discusses the effect of thunder on the production of hail, and quotes letters on the subject. He finds that two-thirds of the heavy hailstorms that have been carefully studied are accompanied with loud thunder ("tuoni forti o fortissimi"), and that the frequency of the thunder, both before and during the hail, does not prevent the formation of large hailstones. In one storm at Campofreddo, near Genoa, where the hail was large and abundant, the thunder was so violent as to break windows. The theory according to which hail is dispersed by cannonades, as the result of the atmospheric waves produced, derives no support from the observed results in connection with either volcanic explosions or thunder.

THE latest issue of the *Zeitschrift für wissenschaftliche Zoologie* (vol. lxx. part iv.) contains four papers, as usual, of a highly technical nature. The first, by Dr. E. Botezat, treats of the terminations of nerves in the taste-corpuscles. In the second, Herr P. Morgenstern describes the development of the hydroid zoophyte *Cordylophora lacustris*. Certain reproductive organs of sharks form the subject of a long article by Herr O. Huber; while Dr. E. Ballowitz treats of the gastrulation of the ovum of the common grass-snake. All the articles are illustrated by plates.

IN a pamphlet published at Frankfurt-am-Maine and bearing the title "Der Zoologische Garten des Museu Goeldi in Pará (Brasilien)," Dr. G. Hagmann, an assistant on the staff, gives an excellent and well-illustrated account of the rise and progress of the menagerie which has been formed under the direction of Dr. E. Goeldi, the able chief of the museum. It was in 1893 that Dr. Goeldi, then attached to the museum at Rio, was appointed to take charge of and reorganise the museum at Para; but, owing to the military revolution which then disorganised the greater part of Brazil, it was not till late in the following year that he was able to assume the duties of his new post. It was not long before his attention was directed to the formation of a zoological garden to illustrate the local fauna, and by 1895 this was in full working order. In the present pamphlet we have a list of the vertebrates—all natives of Brazil—which have been exhibited in the garden between July, 1895, and July, 1901. These comprise sixty-five species or races of mammals, one hundred and twenty-seven of birds, thirty-five of reptiles and amphibians, and nine of fishes. Many of the species exhibited are very rare, and much new information has been acquired in regard to the habits of several. Judging from the photographs with which the pamphlet is illustrated, the appearance of the garden must be highly attractive, and the idea of devoting it entirely to the local fauna is most excellent.

NOTICING that the tang of the head of some Eskimo arrows are provided with a screw, Herr Krause asks whether the screw is an Eskimo invention (*Globus*, lxxix. 1901, p. 8), for it would be strange if a people still in their stone age had in a mechanical contrivance progressed beyond highly cultured, superfine Romans of the Empire. Dr. Karl von den Steinen (*Globus*, lxxix. p. 125) answers this question in the negative, and points to the considerable trade there has been between the natives and numerous European sailors during the last century, and any extensive collection of Eskimo objects will also demonstrate that borrowing has taken place. Mr. H. Newell Wardle replies to Dr. von den Steinen (*Globus*, lxxx. 1901, p. 226) and points out that the Eskimo sometimes made their harpoon heads of the tooth of the narwhal, and as this has a spiral twist there is no need to seek elsewhere for a screw; he therefore thinks it will probably always remain an open question. The relation of the sickle to the saw, on the one hand, and to the dagger on the other is the subject of a learned philological and ethnographical treatise by Herr Hugo Schuchardt in *Globus* (lxxx. pp. 181 and 204).

A SECOND edition of the second volume of Prof. J. R. Green's "Manual of Botany" has been published by Messrs. J. and A. Churchill. The volume is concerned with plant classification and physiology, and several additions have been made with the view of increasing its usefulness and rendering it more readable. Prof. Green provides students with a valuable course of training in systematic botany and plant physiology.

WE have received the following botanical reprints from the United States, the first three being from the *Botanical Gazette*:—"A Study of the Sporangia and Gametophytes of *Selaginella apus* and *S. rupestris*," by Florence M. Lyon, a very careful study, illustrated by five plates; "Development of the Pollen in the Asclepiadaceæ," by T. C. Frye, from which it would appear that the connection of the pollen-grains into pollinia in this order is not associated with any speciality in the mode of development of the sporange; "Further Notes on the Physiology of Polymorphism in Green Algæ," by B. E. Livingston, relating chiefly to the effect on Algæ of cultivation in various nutrient solutions; "The Seed-coats of certain Species of the Genus Brassica," by A. J. Pieters and Vera K. Charles, being *Bulletin* No. 29 of the U.S. Department of Agriculture, Division of Botany; "The Progress made in Botany during the Nineteenth Century," by Wm. Trelease, from the *Transactions* of the Academy of Sciences of St. Louis.

THE fact that the atomic weights of some of the most important elements have not as yet been determined with a sufficient degree of precision is clearly illustrated by a new determination of the atomic weight of calcium by F. W. Hinrichsen, the results of which are published in the last number of the *Zeitschrift für physikalische Chemie*. In spite of the importance of this element and numerous investigations carried out to determine its atomic weight, the latter cannot be said to be known with certainty. The value generally accepted as being most trustworthy is the result of a determination by Erdmann and Marchand in 1850, in which they obtained $Ca = 40{\cdot}00$.

This is the number given on the tables of atomic weight issued by the German Chemical Society. Hinrichsen's method consists in the conversion of extremely pure Iceland spar into oxide of calcium. The only measurable impurity present in the spar was iron, the amount of which expressed as ferric oxide was ·032 per cent. The conversion into oxide was effected in specially constructed platinum crucibles, the latter being heated in an electric oven at a temperature of 1200–1400° C. Four determinations of the atomic weight gave respectively 40·144, 40·141, 40·142 and 40·141—mean =40·142. This number deviates considerably from that which up to the present time has been generally accepted.

IN a paper on the fossil shells of the Colorado desert, published in a recent issue (No. 1256) of the *Proceedings* of the U.S. Museum, Dr. R. E. C. Stearns gives an interesting account of the formation of the desert itself. Surrounded by mountains except in the south, where it opens out, the Colorado desert of California was evidently once an extension of the Californian Gulf, which must once have reached inland some two hundred miles further than at present. The separation of the upper end of this old gulf, now forming the desert, has been caused by the sediment brought down on the east side by the Colorado river, which gradually silted up this portion of the gulf till the present desert area was isolated. Throughout the desert are to be found thousands of small fresh-water subfossil shells, mostly referable to the genera Paludestrina and Physa, which appear to have been transported partly by whirlwinds, but chiefly by birds. Some of the species of these molluscs are still living in certain localities in the desert. The remarkable variation exhibited by the shells of certain species is described in detail.

THE additions to the Zoological Society's Gardens during the past week include a Green Monkey (*Cercopithecus callitrichus*) from West Africa, presented by Mr. F. S. Davidson; a Verreaux's Guinea-fowl (*Guttera edouardi*), a West African Python (*Python sebae*, var. *natalensis*) from Natal, presented by Mr. W. Champion; a Hudson Bay Squirrel (*Sciurus hudsonius*) from the Rocky Mountains, presented by Mr. Edward Whymper; a Lesser Sulphur-crested Cockatoo (*Cacatua sulphurea*) from Moluccas, deposited.

OUR ASTRONOMICAL COLUMN.

DIMENSIONS OF THE PLANETS AND SATELLITES.—In the *Astronomische Nachrichten* (Bd. 157, No. 3760), Prof. E. E. Barnard presents a series of revised reductions of measures made at the Lick Observatory in 1894 and 1895, together with recent determinations with the 40-inch refractor at the Yerkes Observatory.

Mercury.—The measures of diameter were made in the daytime, when the disc of the planet was little brighter than the sky background. Powers of 230, 460 and 700 diameters were used, and a piece of amber-coloured glass was placed as a screen over the eye-piece. The resulting mean value of the diameter was 2965 miles. During the observations the disc of the planet was carefully examined for the linear canal system described by other workers, but no such markings were seen. Under excellent conditions (especially on August 31, 1900), however, decided details in the form of three or four large darkish spots were readily distinguished, and were comparable to the markings on the moon as seen with the unaided eye.

Venus.—Measures were made of this planet specially to determine the extent of variation due to irradiation; night and day measures were both made with the full aperture of 40 inches, but the amber screen was used for the day series. The value obtained for the irradiation was 0″·25. The day diameter of the planet is given as 7713 miles. A series of dusky markings were the only features observed on the disc, similar to but fainter than those on Mercury.

Minor Planets.—Measures of the albedos and diameters of the four chief asteroids were obtained, with the following results:—

	Albedo. Mars = 1.	Diameter.
Ceres	0·67	477 miles.
Pallas	0·88	304 ,,
Juno	1·67	120 ,,
Vesta	2·77	239 ,,

As seen in the 36-inch and 40-inch telescopes the discs of such asteroids as are measurable always appear well defined and round, with no traces of markings on their surfaces. The corrected values for the other planets are as under:—

	Diameter.
Mars (Equatorial)	4352 miles.
,, (Polar)	4312 ,,
Jupiter (Equatorial)	90,190 ,,
,, (Polar)	84,570 ,,
,, Satellite I.	2452 ,,
,, ,, II.	2045 ,,
,, ,, III.	3558 ,,
,, ,, IV.	3345 ,,
Saturn (Equatorial)	76,470 ,,
,, (Polar)	69,780 ,,
,, Satellite Titan	2720 ,,
Uranus (Equatorial)	35,820 ,,
,, (Polar)	33,921 ,,
Neptune	32,900 ,,

No markings were observed on Neptune, and its disc always appeared round.

HARVARD COLLEGE OBSERVATORY REPORT, 1901.—In his report for the year ending September 30, 1901, Prof. E. C. Pickering first mentions that of the three important astronomical events of the year, the Harvard College Observatory staff only participated in the determination of the light variation of Eros and the complete investigation of the changes of Nova Persei. The reason why no measures of Eros for parallax were made was that some fifty other institutions were cooperating in the work, rendering observations at Harvard unnecessary; in the case of the total eclipse in Sumatra the conditions were not considered sufficiently favourable to justify any large expenditure.

East Equatorial.—This instrument has been employed, as in former years, for photometric light comparisons with the achromatic prism polarising photometer; more than 16,000 settings have been made, including 1224 measures of the magnitude of Nova Persei. For double stars, &c., too close for examination with the above instrument, a second photometer has been adapted, and 2278 settings made with it. Other work with this equatorial has been the photometric measurement of Jupiter's satellites while undergoing eclipse, the light variations of the minor planet Eros and the asteroids Vesta and Tercidina, comparisons of long-period variables, and the selection and measurement of twelfth-magnitude standards.

West Equatorial.—This has been employed for similar photometric work on variables and comparison stars.

Meridian Circle.—Work with this instrument has chiefly consisted of zone observations to compare results obtained by use of crossed spider threads or ruled glass plates. The conclusions have been published in *Annals*, vol. xli. No. 7.

12-inch Meridian Photometer.—With this instrument 54,448 settings have been made by the director on 126 nights. A catalogue of 9233 Durchmusterung stars has been completed, and the planet Eros observed on 56 nights.

Meridian Photometer.—33,316 settings have been made on 98 nights, the principal work being the observation of a catalogue of 376 standard stars of the fifth magnitude; also comparison stars for Eros and other similar objects.

Henry Draper Memorial.—With the 11-inch Draper telescope 673 photographs have been obtained, and with the 8-inch instrument 1766 photographs. The total number of photographs taken during the year was 4081. Two new variables, three stars with peculiar spectra, and the presence of bright hydrogen lines in the spectrum of U Andromedæ, have been detected. Photographs of the spectrum of lightning were obtained with the Draper telescope with objective prism during the summer.

Respecting the production of stellar spectra two new devices are announced. For photographing the spectra of stars near the horizon, below 10° altitude, the plan has been adopted of turning the objective prism by a computed amount so as to correct for the atmospheric refraction in declination. The stellar

spectra have been shaded automatically during the process of reproduction so as to equalise the intensity throughout.

As systematic work the 8-inch telescope covers all parts of the sky north of declination $-12^{\circ}\cdot5$ from two to four times a year; the Cooke lens covers all parts available two or more times a month, and the transit photometer records all stars visible to the naked eye crossing the meridian every clear night.

Arequipa Station.—The 13-inch Boyden telescope has been used for photographing clusters containing probable variable stars. With this instrument 140 plates have been obtained; 2269 with the 8-inch Bache telescope and 919 with the 24-inch Bruce lens. From the examination of these latter plates 298 new nebulæ have been found, of which 9 are spiral and 3 ring nebulæ.

The long focus telescope is now back from Jamaica, where a long series of photographs of the lunar surface has been obtained under five different illuminations. These will furnish material for a photographic atlas. The diameter of the moon's image is about fifteen inches.

Blue Hill Meteorological Station.—Continued experiments are being made in the exploration of the upper atmosphere by means of kites, altitudes up to 12,550 feet having been obtained. Considerable success has attended the endeavour to fly the kites from ocean-going vessels in order to record weather conditions away from land surfaces.

TOTAL ECLIPSE OF THE SUN, MAY 18, 1901.—In *Popular Astronomy* (vol. x. pp. 1–4, January), Prof. A. N. Skinner gives an account of the expedition to Sumatra from the United States Naval Observatory. Three stations were selected, at two of which the weather conditions were unfavourable. At the third, Fort de Koch, excellent photographs of the corona and the chromospheric spectrum were obtained. The former were taken with a lens of 5 inches aperture and 39 feet focal length; two of these are reproduced with the article; the spectroscopic equipment consisted of a 30-feet concave grating spectrograph, with which six photographs were obtained.

A MAGAZINE OF SCIENCE AND PHILOSOPHY.[1]

"ANOTHER new magazine!" But the editor, in anticipating this exclamation, suggests that it is no more reasonable than would be "Another new flower in the fields!" or "Another new tree in the wood!" Still, one is not obliged to pluck the flower or to cut down the tree; but a new magazine makes a certain claim on the attention of the public, especially as it is addressed to the scientific public as well as to philosophers in the stricter sense of the word. Indeed, it is an attempt to induce men of science to interest themselves more in philosophy and students of philosophy to pay more attention to modern science. It is not intended to serve as a means of popularising either of these regions of thought, and the editor promises to exclude all purely speculative matter for which an experimental basis is wanting.

The first number contains an interesting article by Mach on "Similarity and Analogy as an aid to Investigation," in which Huygens, Faraday, Maxwell and Kelvin are held up as examples of investigators who have made sound use of analogy and have contributed, in consequence, greatly to the progress of human knowledge. Wald contributes "Critical Studies on the most important Fundamental Conceptions of Chemistry." It must be confessed that this introduction (for more is promised hereafter) is not very intelligible. "The Principle of Continuity in the Mathematical Treatment of Natural Phenomena" is the title of an article by Anton Scheye. The first chapter considers the principle as illustrated in the calculus; the second deals with the principle of continuity in natural science; the third, in mechanics; the fourth, in electrical and thermal phenomena; in the fifth the kinetic theory of gases is discussed; and the sixth chapter treats of the hypothesis of matter and of energetics. Here objections are raised to Ostwald's conclusion that "Our senses tell us of differences in energy between them and their surroundings"; for it is remarked that if equal quantities of energy be imparted to two bodies of equal mass yet of different specific heat, having the same initial temperature, while the final temperature of each will be the same, heat will have passed from the one of lower to the one of higher specific heat; and yet each will affect the sense of temperature equally, though they have gained different amounts of energy. He insists, therefore, that besides energy there must exist some other magnitude which must not only be capable of mathematical treatment, but must be as necessary for the true description of occurrences as energy itself. He also questions whether the doctrine of energy suffices to describe such a stationary condition as two equal light-rays polarised at right-angles to each other, or to picture the stationary state which exists when energy flows in a field of permanent magnets and charged conductors, according to Poynting's law. For these and other reasons he regards it as probable that an interpretation of the universe will be more complicated than would be the case were Ostwald's energetic conception possible.

Ostwald contributes a critical article on Kant's "Metaphysical Basis of Science." To Kant's statement that true science must treat its subject-matter according to *a priori* principles, and that only science falsely so-called deals with laws deduced from experiment, Ostwald replies by denying the possibility of *a priori* conclusions, and maintains that all knowledge is derived from experience. Another celebrated dictum of Kant's is that in any investigation of Nature only so much real science is present as is expressible in mathematical terms; Ostwald insists, however, that mathematics is only a language in which the results of experiments may be conveniently expressed, and that it can contain nothing more in its conclusions than what experiment lends to its premisses. And while Kant, although acknowledging that in principle his scientific treatise has a close connection with the ordinary province of metaphysics, to wit, God, Freedom and Immortality, distinguished them sharply, regarding the former "as a shoot from the same root as the latter, but one which hinders its regular growth," Ostwald maintains that no stronger argument can be found for the necessity of a purely experimental basis for all branches of knowledge.

A somewhat technical article by Arthur von Oettingen on "The Dual System of Harmony," and one by E. Sievers on "Melody of Voice in (Reciting) German Poetry," are followed by reviews of new books by the editor. Among these it is somewhat amusing to find Judge Stallo's "Concepts of Physics," which has only now reached the German public, through its translator, H. Kleinpeter. W. R.

[1] *Annalen der Naturphilosophie.* Edited by Wilhelm Ostwald. (Veit and Co.). Price 14 Marks, yearly.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

CAMBRIDGE.—Mr. T. H. Middleton, professor of agriculture in the Durham College of Science, Newcastle-on-Tyne, has been elected to the chair recently vacated by Dr. Somerville.

Dr. Barclay-Smith has been reappointed senior demonstrator of anatomy.

The Vice-Chancellor, Prof. J. J. Thomson, and Mr. R. T. Wright will represent the University at the jubilee of Owens College, Manchester, to be celebrated next March.

EDUCATION was given first place in the King's speech to the Commons at the opening of Parliament last Thursday. The words used were "Proposals for the Co-ordination and improvement of Primary and Secondary Education will be laid before you." It is to be hoped that a comprehensive measure will be introduced early in the session, and that nothing will be permitted to interfere with the settlement of the questions involved in it.

THE adoption of the metric system of weights and measures would be so much to the advantage of the work of education and commerce in this country that efforts should be made to bring the subject forward on every suitable occasion. We are, therefore, glad to see that the following resolution was passed at a general meeting of Convocation of the University of London on Monday:—"That this House is of opinion that, in the interests of commerce, science and education, legislation should be promptly undertaken to make compulsory in this kingdom, after a proper interval, the use of the metric system of weights and measures for all purposes."

PROF. ALFRED LODGE stated the case for reform in methods of teaching geometry at the annual meeting of the Mathematical Association held on Saturday last. He urged that a new text-book of geometry, framed more or less on the model

of books used in France, should be introduced as soon as possible to supersede Euclid's elements. Text-books adapted to modern needs are in use in the United States of America, and their chief characteristics are :—(1) The more orderly arrangement of propositions ; (2) the entire separation of theorems from problems of construction, hypothetical constructions being used in proving a theorem ; (3) the closer association of a proposition and its converse when both were true ; (4) the adoption of arithmetical notions and algebraic processes ; (5) the early introduction of simple *loci* ; (6) insistence on accurate figures drawn by accurate and practical processes ; (7) practice in exercises from the very beginning. It had been suggested to Prof. Lodge that he should add, "Attention paid to the various phases of a theorem as the figure changes, and (as the student progresses) to the easier forms of generalisation." The greater part of these improvements could be adopted at once, provided that the sanction of the great examining bodies could be obtained. A committee of the Association is being formed to cooperate with the committee of the British Association in advancing the reforms advocated in mathematical teaching.

THE work of the Sir John Cass Technical Institute, London, was inaugurated on January 15, when an introductory address was given by Sir William Roberts-Austen, K.C.B., F.R.S. The institute has been founded by the governors of Sir John Cass's Foundation, and is one of the London polytechnics aided by the Technical Education Board of the London County Council and by the City Parochial Foundation. The institute is situated in Jewry Street, Aldgate, and is readily accessible. It is provided with good laboratories for chemistry, metallurgy and physics, and on the art side with workshops and drawing rooms for the department of arts and crafts. Dr. C. A. Kohn is the principal of the institute. Sir William Roberts-Austen in his introductory address dealt chiefly with the subject of metallurgy. It was, he said, an industrial art depending for its success on what were called the applications of science, but he heartily wished that the term "applied science" had never been devised. There was no essential difference between what was called pure science and what was called applied. In industrial life they simply applied the facts of science to a particular set of conditions or to the solution of definite problems. This view was illustrated by reference to the process of cupellation, the history of which was described and illustrated by suitable experiments. The diffusion of solids was then referred to, and a summary was given of the steps that had led Sir William to the investigation of the diffusion of metals.

THE importance of geography in education was the subject of an address delivered by Mr. James Bryce, M.P., at the annual meeting of the Geographical Association held last week, Mr. Douglas W. Freshfield, president, being in the chair. The Association aims at the improvement of the teaching of geography by spreading the knowledge of all such methods as call out the pupil's intelligence and reasoning powers and make geography a real educational discipline, instead of merely loading the memory with names and isolated facts. After expressing his hearty sympathy with the objects of the Association, Mr. Bryce considered the place of geography in education under three aspects, viz., as the gateway to the physical sciences, the key to history, and the basis of commerce. In this country, as in Germany for some time, it is thoroughly realised by all progressive teachers that geography must be made as much as possible an experimental science—that the pupil's mind must be brought into contact with facts and not alone with words. The pupil taught to observe has it suggested to him how things are connected with one another ; he acquires the habit of looking at the country and asking himself what are the physical causes which make the district what it is, and what is the relation between those different causes. As to geography being regarded as the basis of commerce, Mr. Bryce said that the producer and merchant ought to know where each article could be best produced, where the raw material comes from, what are the conditions of labour, which are the best points of manufacture, where are the best markets, and what are the lines of communication and transport. Although the commercial man has to rely upon trained observers he would do better if he acquired geographical knowledge himself, because he could develop for himself certain lines of policy upon which he could conduct his operations ; his wider knowledge of the world would enable him to take, not only a more intelligent, but a more practically serviceable view of the action which in each particular case was to be taken, and which, of course, would be constantly shifting. If the heads of great business houses were thoroughly trained to observe these things and to look at them in a scientific way, a great deal would be done to enable the country to hold its place in the great commercial world.

IN view of the recognition with which scientific training is now meeting, as part of our educational system, some of the suggestions made at the Conference of Public School Science Masters on January 18 are of interest. Those responsible for the framing of the regulations for Army examinations were unanimously recommended by scientific men from all the great public schools, and from many others, to lay more stress upon the practical side of the science work. It was, further, suggested to them that quantitative work should be introduced and that physics should be given the place it deserves in the compulsory science papers. Moreover, what is to be sought is not knowledge-worship, but training, not the old-fashioned theoretical questions with which examiners find it so easy to elicit facts, but the construction of problems which, when worked out practically under their own eyes, will truly tell them the capabilities of the candidates. Testimony was also forthcoming that there are examiners who will take the trouble to examine in the latter way, and the meeting was in favour of allowing that greater scope to assistant practical examiners which they must have if large numbers of persons are to be examined at one time. The pernicious specialisation which takes place in schools as a result of the examinations for science scholarships at the Universities of Oxford and Cambridge was made abundantly clear, and some system advocated which will prevent this and at the same time ensure all boys in the school—and not the "intellectual refuse" and Army classes alone—having a proper scientific training for several years, whether they be classical or modern, literary or mathematical. A committee, it has been arranged, is to take up the matter. A sidewind during the discussion, as to whether classical boys do better than others in scientific work elicited the fact that at Woolwich, for instance, no rule one way or the other could be laid down. The necessity of culture as well as scientific education was a point that was touched upon, and might well form the subject of a future discussion. Biology as a school subject was rather pooh-poohed by one representative from Cambridge University, while its importance was just as strongly urged by a public school master. It came as no surprise to those familiar with what occurred last year, that a definite association was formed as a result of the conference which will arrange for similar and possibly more frequent meetings in the future. Principal Rücker has consented to become the first president of the Association of Public School Science Masters—a body the constitution of which will be somewhat elastic, as it is difficult to define what is a public school science master, but the title is sufficiently rigid to specify the character of the Association.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, June 20, 1901.—"The Anomalous Dispersion of Sodium Vapour." By R. W. Wood, Professor of Experimental Physics, Johns Hopkins University, U.S.A.

The modern theories of dispersion show that the effect of an absorption band is to lower abnormally the refractive index of the medium on the side of the shorter wave-lengths and raise it on the side of the longer wave-lengths. In some cases even the refractive index may fall below one on the blue side of the band, which means that light of a certain wave-length travels through the medium at a higher velocity than in a vacuum. Substances showing this peculiarity are exceedingly opaque to light, a thickness of a few wave-lengths absorbing completely all of the light for which this peculiarity exists.

It is quite possible to conceive of a medium with a strong absorption band in the middle of the visible spectrum having a refractive index greater than unity for all waves longer than the absorbed waves, and a refractive index less than unity for all shorter waves. A prism made of such a substance would deviate half of the spectrum in one direction and half in another direction, something in the manner of the direct-vision prism, except that the arrangement of the colours would be anomalous. Such a medium has been found in metallic sodium vapour, which is most beautifully transparent in addition to having the peculiarity

before mentioned. By means of prisms of sodium vapour it is possible to form a complete anomalous spectrum, in which all the colours between the extreme red and violet are present, with the exception of a very narrow range at the D lines. It has been found that the refractive index is one for the extreme violet, greater than one for all colours on the red side of the D lines, and less than one for all colours on the other side, the maximum and minimum values occurring, of course, close to absorptionbands (the D lines).

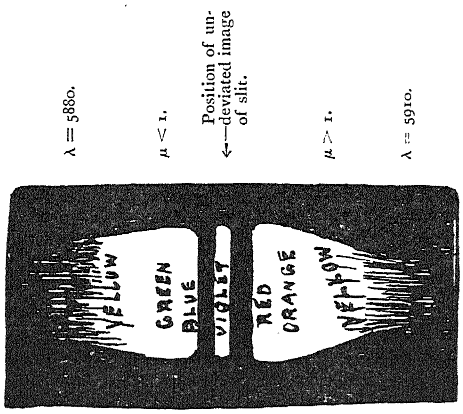


FIG. 1.

In the spectrum produced by a prism of sodium vapour the violet occupies the position of the undeviated image of the slit, the red and orange flaring off to one side, and the blue, green and yellow to the other, as is shown in Fig. 1.[1]

Inasmuch as sodium vapour appears to be the substance best adapted to class demonstration of anomalous dispersion, it is worth while to describe in some detail the apparatus by which the remarkable optical properties of the vapour can be exhibited, referring the reader to the original paper for a more complete discussion. (The paper is to appear also in the *Philosophical Magazine*.)

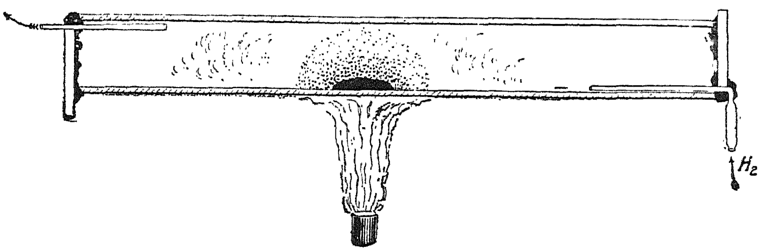


FIG. 2.

The first experiments were made with a large prism of cast iron, furnished with windows of mica or thin plate glass, in which the metal was heated in an atmosphere of hydrogen. Very beautiful results were at once obtained, but certain peculiarities of the vapour's action showed that the refraction was due chiefly to the action of a non-homogeneous medium, the planes of constant density being horizontal. Great trouble was caused by the windows, which soon became covered with a white deposit, which cut off most of the light. It being apparent, however, that the oblique faces played but a very small part, the effect being due almost wholly to the variable density of the vapour, it seemed best to make the most of this circumstance and dispense with the trouble entirely by removing the glass plates to such a distance from the heated vapour that no deposit took place. The arrangement finally adopted was simply a tube of glass about 30 cm. long, provided with plate-glass ends cemented on with sealing-wax. Hydrogen dried by passage over calcium chloride was conducted into and out of the tube by means of two fine glass tubes, arranged as shown in Fig. 2.

The diameter of the tubes should not be more than 2 mm., and they should lie close against the sides of the large tube in order not to cut off any of the light. The most suitable diameter for the large tube is 2 cm. The ends of the tube are first warmed and thickly coated with sealing-wax. One of the glass straws is placed in position, and a small piece of plate glass, previously warmed, applied to the end of the tube, any crevices around the straw being closed with wax. The leading-in tube is next placed in position and a piece of freshly cut sodium (about 5 mm. on a side) inserted. The other window is then cemented to the tube and the current of hydrogen started as soon as possible. Some experience is necessary to regulate properly the hydrogen stream during the experiment. When the tube is first heated much white smoke forms. If a stream corresponding to about one bubble per second is allowed to flow, the smoke will usually clear up in a few minutes and give little trouble. The tube should be heated by means of a Bunsen burner turned down low, the tip of the flame playing against the bottom of the tube. If a sodium flame is placed behind the tube the formation of the vapour can be watched, for it appears almost jet black against the flame, though quite colourless in white light. The behaviour of the vapour is somewhat peculiar. It grows out from the sodium globule as a dark atmosphere with a sharply defined surface, which clings to the globule with great tenacity. It resembles at first a thick growth of mould more than anything else, and a sudden gust of hydrogen scarcely moves it at all. A wire pushed up through it drags a certain amount above the free surface, in much the same manner as a stick pushed up through the surface of thick molasses would do. If the tube be inverted the black cloud clings to the upper surface, behaving, on the whole, like a very viscous mass. It is even possible to dip some of it up on a wire.

These peculiar physical properties of the metallic vapour have as yet only been studied in a very superficial manner, and they are mentioned now only because it appears that there is some connection between them and the optical behaviour of the medium.

The opinion is expressed that the apparent viscosity is an illusion; that the sharply defined surface is merely the boundary at which either condensation or chemical action (the hydrogen was not absolutely pure) is taking place. The process of dipping the vapour up on the wire might be explained by condensation on the wire followed by vaporisation. A more careful study of the physical behaviour of the vapour will be made some time in the future.

The apparatus employed in the study of the dispersion of the vapour was essentially identical with that used by Becquerel. The light of an arc lamp was focussed on the *horizontal* slit of a collimator, after traversing which the rays passed lengthwise through the dispersion tube. A second lens brought them to a focus on the slit of a spectroscope when the dispersion was to be studied by the method of crossed prisms, or in the focus of an eye-piece when the anomalous spectrum was to be viewed subjectively (Fig. 3).

The first experiments were made by the method of crossed

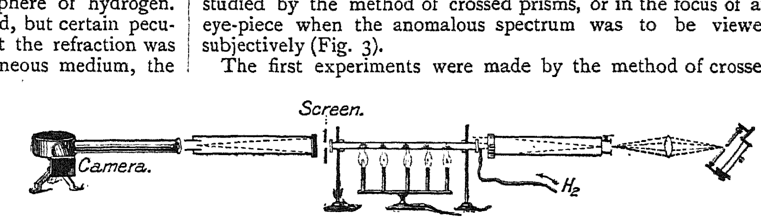


FIG. 3.

prisms, the spectrometer being furnished with a Rowland plane grating, which showed the sodium lines widely separated. It was at once apparent that far better results could be obtained with the dispersion tubes than had ever been observed with prismatic flames. The curved branches of the diffraction

[1] This spectrum is illustrated by a coloured plate in the original paper.

spectrum on each side of the D lines were perfectly sharp and steady, and the dispersion could be traced a considerable distance up and down the spectrum. On the slit of the spectrometer appeared, instead of the white image of the horizontal slit, a most beautiful anomalous spectrum of great brilliancy and purity. The spectrometer was at once removed and an eye-piece put in its place, when a most superb spectrum revealed itself (Fig. 1).

Before discussing this spectrum in detail it will be better to take up the results of the experiments made by the method of crossed prisms. On first heating the tube the curvature of the

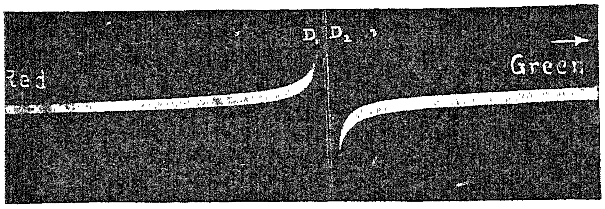


FIG. 4.

spectrum between the D lines as well as on each side is observed, the appearance being identical with that figured by Becquerel, but in a few seconds the vapour becomes so dense that total absorption of all the light between the lines occurs. The oppositely curved branches adjacent to the region of absorption extend rapidly up and down as the tube grows hotter, the ends finally passing out of the field of the instrument. A beautiful fluted absorption appears in the red and the greenish-blue, which finally blots out a region in the blue almost entirely. Meanwhile the curvature of the spectrum

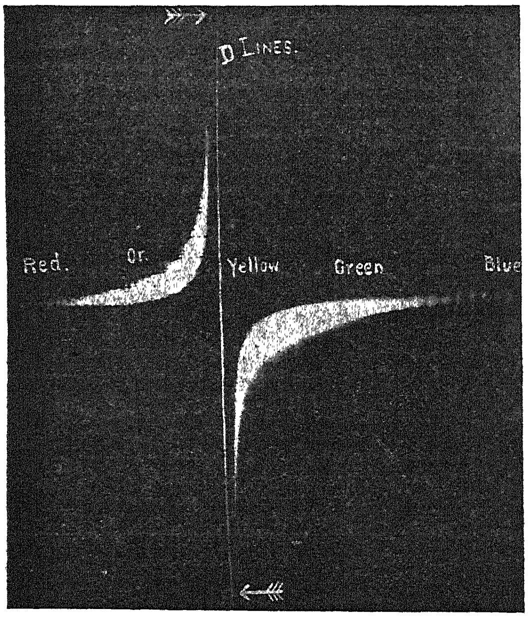


FIG. 5.

increases in a most remarkable manner, and the entire red end is lifted high above the green-blue end. As the density of the vapour increases the red gradually fades away, leaving only the yellow and green and the remote blue and violet, the curvature increasing all the while.

Figs. 4 and 5 are photographs of the continuous spectrum after dispersion by means of a prism of sodium vapour. They give a very good idea of what is seen with the apparatus arranged as shown in Fig. 3. The sodium lines were impressed on the plate by holding a sodium flame in front of the slit of the spectrometer after the exposure was over. In Fig. 5 the arrows indicate the points to which the curved branches could be traced in the original negative. Eye observations enable them to be traced much farther, for they are very feeble at the tips, and the light is not very actinic.

For the exhibition of the actual spectrum produced by a prism of sodium vapour a long dispersion tube with a battery of four or five prisms gives the best results. A small Bunsen burner should be used for each of the fragments of sodium, which should be at least 6 or 8 cm. apart. A coloured drawing of the spectrum, which has already been mentioned, was made when the spectrum was obtained in this manner. A single prism gives a very pretty anomalous spectrum, but the magnificent effect produced by the battery makes the slight amount of extra trouble well worth while. If the electric arc is employed as the source of light, the extreme violet will be found to occupy the position of the undeviated image of the slit (Fig. 1). Then comes the blue, sometimes in contact with the violet and sometimes slightly separated by a fine dark line, owing to the fact that the violet light comes from the fluted carbon band of the arc, which is separated from the blue by a comparatively dark region. Then comes a wide gap corresponding to light absorbed by the sodium vapour in the blue-green region (the channelled spectrum), and above this a beautiful flare of colour ranging from blue-green through grass-green to yellow. The red and orange portion of the spectrum is on the other side, or below the undeviated image, forming another brilliant flare of colour. It is separated from the violet by a wide dark band, due to the absorption in the vicinity of the D lines. If the density of the vapour is increased by heating the tube to a higher temperature, the red flare extends lower down, grows fainter, and finally fades away owing to the presence of the fluted absorption bands in the red. The green and blue persist, however, becoming more widely separated, but finally the green disappears almost entirely. It is best to arrange the gas cock so that the height of the flames can be controlled without leaving the eye-piece, for it is surprising how slight a change is necessary to completely alter the general appearance of the spectrum. The glass tube should not be allowed to cool until the experiment is at an end, otherwise it will immediately fly to pieces when the flame is again applied to it.

While glass answers very well if the experiment is to be of short duration, sheet iron is much more satisfactory. Suitable tubes can be made by any tinsmith. They should be made of thin sheet iron, and the turned-over seam should be hammered until a tight joint is formed. These tubes can be heated and cooled any number of times and can be kept in operation for an hour or two, at the end of which time the sodium is generally used up, a moss-like deposit of oxide gradually filling up the tube. The tubes can be used over and over again without deterioration, and are most satisfactory in every respect. Their only fault lies in their conductivity, the sealing-wax softening and the glass plates falling off; but this can be prevented by wrapping a strip of cloth around each end and wetting it from time to time. One tube was made with water jackets at each end, but it seems to have no especial advantage, and is more complicated. Porcelain tubes are quite satisfactory, but the iron is to be preferred on the whole.

By employing a tube of about 5 cm. diameter the anomalous spectrum can be projected, but the appearance is so very inferior to that of the phenomenon when seen subjectively that the method is not recommended.

Royal Astronomical Society, January 10.—Dr. J. W. L. Glaisher, F.R.S., president, in the chair.—In a paper on periodic orbits Mr. E. T. Whittaker communicated two theorems relating to the periodic solutions of the differential equations of dynamics and astronomy. The first theorem furnished a criterion for the discovery of periodic orbits; if a certain function of position be negative for all points of a closed curve and positive for all points of a curve enclosing this, then a periodic orbit exists in the ring-shaped space between the curves. The second theorem was concerned with an integral, the value of which when integrated over the region bounded by a periodic orbit is equal to the number of centres of force enclosed by the orbit.—Prof. H. H. Turner read a paper by Major Burrard, of the Indian Survey, on the attraction of the Himalaya Mountains upon the plumb-line in India. A chart was exhibited, showing a supposed underground source of attraction running across central India.—Lantern slides were shown of photographs taken by

Mr. Ritchey at the Yerkes Observatory of the nebula surrounding the new star in Perseus, and Mr. Newall described Prof. Kapteyn's suggested explanation of the apparent rapid motion of the nebula as shown in the photographs.—Mr. Lewis read a paper on the orbit of the binary star Σ 1639 in Coma Berenices. —The secretary read a paper by Mr. Robinson, of the Radcliffe Observatory, Oxford, upon a comparison of the visual and photographic magnitudes of Nova Persei.

Linnean Society, December 19, 1901.—Prof. S. H. Vines, F.R.S., president, in the chair.—Prof. G. B. Howes exhibited a marine organism received from Dr. Gilchrist, of South Africa. It measures 15 cm. in length, and is structureless and transparent, in section four-sided, with its angles prolonged and each intervening area concave. A central tubular cavity is present, and at one end a deep constriction, which may be due to wave-action or other artificial causes. Ideas of a ctenophoran, the cast-off test of a tunicate of the distoma type, of a myxicolid worm-tube, an egg-capsule, and others which had occurred, had all been discarded; and after having submitted the object to a dozen trained experts, he put it forward in the hope of obtaining a clue to its significance and zoological position. In commenting upon this exhibit, the president said he believed the occasion was probably the first in the history of the Society upon which an object had been laid upon the table to which no one could give a name.—Prof. Howes also exhibited a mounted specimen of the giant argulus (*A. scutiformis*) from a Japanese Tetrodon. —Mr. J. E. S. Moore exhibited the entire specimen and a microscopic preparation, with drawings, of a new polyzoon, encrusting the shell of Paramelania, dredged on the west coast of Lake Tanganyika, at a depth of 25 fathoms. He showed it to be typically gymnotæmatous, and to present characters most nearly suggestive of the marine genus Arachnidium.—Dr. C. W. Andrews gave a short account of his recent visit to Egypt, and showed lantern-slides illustrating some of the districts in which vertebrate fossils were collected. The most important journeys were to Mozara with Mr. T. Barrow, and to the Fayûm with Mr. H. J. L. Beadnell, officers of the Egyptian Geological Survey. In the former locality remains of Mastodon, Brachyodus and other vertebrates of Lower Miocene age were found; and in the latter a large series of bones from Middle and Upper Eocene beds was collected. These bones include a number of very interesting forms, some of which (Palæomastodon and Mœritherium) seem to be early proboscidians, and indicate that that group originated in an Ethiopian land-area which became united to the Palæarctic land in Oligocene times. A number of plaster-casts of some of the more important specimens were shown.—Mr. Miller Christy exhibited and made remarks on a specimen of White's Thrush, *Turdus varius*, Pallas, which had been shot near Clavering, in Essex, so long ago as January 1894, and had been preserved for Mr. Rolfe, but had only recently been identified as a rarity. Mr. J. E. Harting stated that about the same time another bird of this species, which he had seen, had been procured near Southampton, and that the two might well have arrived in company from Siberia. After pointing out the geographical distribution of the species and its distinguishing characters, he exhibited coloured figures of the egg, which is one of the rarest in collections; and, for comparison, a figure of the egg and nest of the allied *Turdus lunulatus* of Australia.—The Rev. John Gerard exhibited a nest of the sand-martin (*Cotile riparia*) made within the nest of a dipper (*Cinclus aquaticus*), found near Bashall Hall, Yorkshire, in which eggs of the former bird had been laid and hatched after the latter had ceased to occupy it.—Mr. S. Pace exhibited specimens of the common Torres Straits snail *Planispira* (*Trachiopsis*) *delessertiana*. He likewise exhibited a specimen and drawings from life of a rare pelagic tectibranch, *Euselenops* (*Neda*) *luniceps*, taken in Friday Island Passage, Torres Straits. —Mr. S. Pace read a paper on the gasteropod Pontiothauma, Sm., giving an account of the anatomy of this remarkable genus, with special reference to the proboscis and its associated parts, as observed in a specimen from the Indian seas, furnished some years ago by Dr. Alcock, of the Calcutta Museum.—Mr. F. Chapman read a paper on the Ostracoda collected round the Funafuti Atoll. This collection, which had been placed in his hands for examination and description by Prof. Judd, C.B., F.R.S., was obtained from various sources during the work of the expedition for the purpose of boring in the Atoll. The specimens represented the recent deposits obtained by dredging outside the Atoll, chiefly at moderate depths, but many were also selected from the dredgings in the lagoon, as well as from the beach-sands, the deep-sea deposits and the sands from the Atoll boring. The total number of species was fifty-two, six of which were found to be undescribed. The occurrence of the genus Limnocythere was considered noteworthy on account of its fresh-water habit.

Royal Meteorological Society, December 15, 1901.—Mr. W. H. Dines, president, in the chair.—The Symons gold medal was presented to Dr. Alexander Buchan, F.R.S., for his work in connection with meteorological science.—The president in his address dealt with the theory of probability applied to various meteorological problems. He considered that for all practical purposes weather conditions may be looked upon as purely accidental, and that we may apply to them the laws of chance. They are not by any means in reality a matter of chance, for although we cannot discover it, there is doubtless a cause for each kind of weather, normal or abnormal. After speaking upon the subject of weather forecasting, he dealt with the question, How long is required to obtain a true average? He has come to the conclusion that ten years' temperature observations give a mean of which the probable error is a little under one degree; thirty years reduce this to half a degree, fifty years to one-third of a degree, and a hundred years to one-quarter of a degree. After dealing with barometer observations and rainfall, he proceeded to speak of weather almanacs, cycles, &c. In conclusion he said that meteorology is far more than a statistical science, and is very closely dependent upon theoretical mechanics and thermodynamics, and in the application of these subjects to meteorology lies the best hope of advance. The council for the ensuing year were then elected, Mr. W. H. Dines being the president and Mr. F. C. Bayard and Dr. H. R. Mill secretaries.

PARIS.

Academy of Sciences, January 13.—M. Bouquet de la Grye in the chair.—On the periods of double integrals and on a class of linear differential equations, by M. Émile Picard.—The preparation and properties of the hydride of sodium, by M. Henri Moissan. Metallic sodium is attacked by hydrogen gas at a temperature of about 400° C., the hydride thus formed dissolving in the excess of metal, from which it can be isolated in a slightly impure state by treatment with liquefied ammonia at −40° C. Pure sodium hydride was finally obtained by heating sodium wire in hydrogen at 370° C., keeping the upper portion of the tube slightly cooler. Under these conditions the hydride condenses on the cooler part in crystals, which upon analysis proved to be NaH. It is attacked by the slightest trace of water and catches fire in moist air. The hydride is attacked by gaseous fluorine and chlorine, but remains unaltered in the presence of liquid chlorine at −35° C. It resembles potassium hydride in its powerful reducing properties.—The cultivation of lucerne upon soils without lime, by MM. P. Dehérain and E. Demoussy. Lucerne and clover grow feebly in soils without lime if the bacteria-producing nodosities are present. The addition of lime increases the vigour of growth in both cases.—On integral parameters, by M. Alf. Guldberg.—On the theory of entire functions, by M. Pierre Boutroux.—On radioactive bodies, by M. P. Curie and Mdme. S. Curie. The authors have taken two hypotheses as guiding principles in their researches on the radioactive bodies; that radioactivity is an atomic property of bodies, and that each atom of a radioactive substance behaves as a constant source of energy. Experiments carried out over several years show that for uranium, thorium, radium and probably actinium, the radiant activity remains constant if the chemical and physical state of the radioactive body remains the same. Polonium alone appears to be an exception to this rule. —A principle relating to the distribution of the lines of magnetic induction, by M. Vasilesco Karpen. The principle is laid down that in a magnetic medium submitted to the action of a certain number of magnetomotive forces, the course of the lines of induction is such that the intrinsic energy of the medium is a maximum.—On the difference of potential and the deadening of the oscillatory spark, by M. F. Beaulard. A correction of an arithmetical error in a previous paper.—Telephony without wires through the earth, by M. E. Ducretet. By the use of a microphone, messages were transmitted through the earth with remarkable clearness, without any of the secondary noises so annoying in telephony with conducting wires.—The influence of low barometric pressures on the frequency of the polar aurora, by M. H. Stassano. A clear connection is traced between the frequency of the appearance of the aurora and a low

barometer.—The earthquakes due to folding in the Erzgebirge, by M. F. de Montessus de Ballore. The numerous slight earthquakes in this region are traced to the effect of three long folds in the strata, the Erzebirge being the longest and highest of the three.—On the aberration of sphericity of the eye, by M. Georges Weiss.—The preparation and properties of strontium hydride, by M. Henri Gautier. A strontium-cadmium alloy containing about 45 per cent. of strontium is heated in a current of hydrogen to a dull red heat. The hydrogen is slowly absorbed and the cadmium volatilised. Towards the end of the operation the temperature is raised until the mass is fused. Analyses of the compound showed that its composition was SrH_2. It proved to be analogous both in composition and properties to the calcium hydride of Moissan.—On the chemical equilibrium of the iron-carbon systems, by MM. Georges Charpy and Louis Grenet. The theory of Bakhuis-Roozeboom on the constitution of the compounds of iron and carbon, although complete from the theoretical side, has met with some objections from the practical point of view. The separation of graphite would appear to be largely conditioned by the amount of silicon present. An experimental study of the effect of silicon is given in the present paper.—On the thermoelectricity of steels and nickel-steels, by M. G. Belloc. The proportions of nickel in the nickel-steels studied varied from 5 to 35 per cent. The general form of the curve giving the relation between the electromotive force and the temperature for platinum-nickel steel couples is parabolic, the alloy containing 5 per cent. of nickel being exceptional in this respect. The steels containing 5 per cent. and 28 per cent. of nickel at about 400° to 500° C. show brusque variations, indicating molecular transformations. The 28 per cent. nickel steel is remarkable for its high neutral point and the great electromotive force developed.—The action of mixed organo-magnesium compounds upon trioxymethylene, by MM. V. Grignard and L. Tissier. Trioxymethylene reacts slowly at the boiling temperature upon an ethereal solution of the organo-magnesium compounds with the formation of primary alcohols. Numerous alcohols have been thus prepared synthetically, and the method appears to be of wide generality. Thus starting with ethyl bromide, normal propyl alcohol is obtained with a 65 per cent. yield; the reaction also holds in the aromatic series.—The preparation and properties of the imido-dithiocarbonic esters, by M. Marcel Delépine.—On the inversion of saccharose, by M. P. Petit. An attempt at the direct measurement of the heat of inversion of sugar.—On the solubility of calcium phosphate in pure water, by M. A. Rindell.—On the methods for the volumetric estimation of copper, iron, antimony, zinc dust, sulphur in sulphides, and glucose by means of stannous chloride, by M. Fred. Weil.—On the geographical distribution and adaptation to fresh water of some marine forms, by MM. C. Vaney and A. Conte.—On a crustacean commensal with Pagurus, *Gnathomysis Gerlachei*, a type of a new family of schizopods, by MM. Jules Bonnier and Charles Pérez.—The action of tannins and colouring matters on the activity of yeasts, by M. A. Rosenstiehl.—The mechanism of synthesis of an isomeric leucine, by MM. A. Etard and A. Vila. Leucine derived synthetically from amyl alcohol is different from biological leucine.—On the extraction of boletol, by M. Gabriel Bertrand.—On the fracture of the fore-arm due to a premature explosion in an automobile motor, by M. H. Soret.—The discovery of the mammoth and of a Palæolithic station in Basse-Provence, by M. Repelin.—On the structure of the subterranean hydrographic network in limestone regions, by M. F. Fournier.

DIARY OF SOCIETIES.

THURSDAY, JANUARY 23.

ROYAL SOCIETY, at 4.30.—(1) Mathematical Contributions to the Theory of Evolution. XI. On the Influence of Natural Selection on the Variability and Correlation of Organs; (2) On the Correlation of Intellectual Ability with the Size and Shape of the Head. Preliminary Notice: Prof. K. Pearson, F.R.S.—A Short Description of the Culicidæ of India, with Descriptions of New Species of Anopheles: F. V. Theobald.—The Affinity of Tmesipteris with the Sphenophyllales: Prof. A. P. W. Thomas.—On the Excretory Organs of Amphioxus: E. S. Goodrich.—On the Mechanism of the so-called "Peripheral Reflex Secretion" of the Pancreas. Preliminary Communication: Dr. W. M. Bayliss and Prof. E. H. Starling, F.R.S.

ROYAL INSTITUTION, at 3.—Recent Excavations at Delphi and in the Greek Islands: Dr. A. S. Murray.

SOCIETY OF ARTS, at 4.30.—Bengal: the Land and its People: F. H. Skrine.

INSTITUTION OF ELECTRICAL ENGINEERS, at 8.—Earth Currents derived from Distributing Systems: E. B. Wedmore.

FRIDAY, JANUARY 24.

ROYAL INSTITUTION, at 9.—The Discovery of the Future: H. G. Wells

PHYSICAL SOCIETY, at 5.—The Factors of Heat. Part I.: James Swinburne.—Exhibition of some Twinned Crystals of Selenite: Eustace Large.

SATURDAY, JANUARY 25.

ESSEX FIELD CLUB (at Essex Museum of Natural History, Stratford, Essex), at 6.30.—Note on Occurrence of *Amanita citrina*, Gon. and Rab., in Epping Forest: George Massee.—Local Archæological Exploration: Charles H. Read.

MONDAY, JANUARY 27.

SOCIETY OF ARTS, at 8.—The Purification and Sterilisation of Water: Dr. Samuel Rideal.

ROYAL GEOGRAPHICAL SOCIETY, at 8.30.—The Maldive Islands: J. Stanley Gardiner.

INSTITUTE OF ACTUARIES, at 5.30.—The Actuarial Aspects of Recent Legislation, in the United Kingdom and other Countries, on the Subject of Compensation to Workmen for Accidents: John Nicoll.

TUESDAY, JANUARY 28.

ROYAL INSTITUTION, at 3.—The Cell: its Means of Offence and Defence: Dr. Allan Macfadyen.

SOCIETY OF ARTS, at 4.30.—To the Victoria Nyanza by the Uganda Railway: Commander B. Whitehouse.

INSTITUTION OF CIVIL ENGINEERS, at 8.—The Sewerage Systems of Sydney, N.S.W., and its Suburbs: J. Davis.—The Bacterial Treatment of Trades Waste: W. Naylor.

WEDNESDAY, JANUARY 29.

SOCIETY OF ARTS, at 8.—Technical Education as applied to Paper Making: Clayton Beadle.

THURSDAY, JANUARY 30.

ROYAL SOCIETY, at 4.30.—*Probable Papers*: The Chemical Origins of the Lines in Nova Persei: Sir N. Lockyer, K.C.B., F.R.S.—The Specific Volumes of Oxygen and Nitrogen Vapour at the Boiling Point of Oxygen: Prof. James Dewar, F.R.S.—The Distribution of Magnetism as affected by Induced Currents in an Iron Cylinder when rotated in a Magnetic Field: Prof. Ernest Wilson.

ROYAL INSTITUTION, at 3.—Recent Excavations at Delphi and in the Greek Islands: Dr. A. S. Murray.

FRIDAY, JANUARY 31.

ROYAL INSTITUTION, at 9.—The Ions of Electrolysis: Prof. A. Crum Brown, F.R.S.

INSTITUTION OF CIVIL ENGINEERS, at 8.—The Quay-Walls of Keysham Harbour: J. C. Collett and W. H. C. Clay.

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THURSDAY, JANUARY 30, 1902.

THE ADVANCEMENT OF NATURAL KNOWLEDGE.

THE *London Gazette* announces that a petition for incorporation has been presented to His Majesty on behalf of a new body, "The British Academy for the Promotion of Historical, Philosophical and Philological Studies." An explanation has been given that the object of this institution is to do for the various departments of "literary science" what the Royal Society has achieved for "natural science." The causes which have led up to this proposal may be stated as follows. At a meeting of the representatives of the chief European and American academies held at Wiesbaden in October 1899, an International Association of the principal Scientific and Literary Academies of the world was decided upon. Most of the academies represented are divided into two sections, a section of natural science and a section of historico-philosophical science. And on this ground the scheme provided for the division of the new association into two sections, "scientific" and "literary," the word "literary" being used only as a short title to embrace the sciences of language, history, philosophy, archæology and other subjects the proper study of which is based on scientific methods. At the conference the representatives of the Royal Society, not feeling themselves competent to represent the United Kingdom in the philosophico-historical section, were unofficially requested to take such steps as might be possible to fill this gap in the future.

The next steps taken may be gathered from the Report of the Royal Society Council presented to the Society on November 30, 1901.

The secretaries, apparently in fulfilment of their undertaking at Wiesbaden, wrote on the subject to the president of the Society of Antiquaries, Viscount Dillon, on November 21, 1899. A meeting was called at which, among others, several fellows of the Royal Society and of the Society of Antiquaries were present. The conclusion arrived at was that the idea of an academy to represent the philosophico-historical subjects formed by the simple federation of existing societies was not one which appeared to meet the views of those present.

At the same time the late Prof. Sidgwick drew up a plan which was approved by several of those attending the meeting and "of which the resolution passed at that meeting might be considered a part." This plan pointed out that the Royal Society might enlarge its scope, and include a section corresponding to the "philosophico-historical" and "philological" division of the German Royal Academies and Societies.

The next step taken was the reference of the matter to a special committee of the Royal Society.

The Committee point out that four possible ways of dealing with the matter were submitted to them :—

"(1) The creation of an organisation independent of the Royal Society, though possibly in some way connected with it, in which case they might both form parts of some larger body, as, for instance, the French Academies form parts of the Institute of France.

"(2) The creation of two 'Academies' within the Royal Society, one of Mathematics and Natural Sciences, the other of Philosophy-History, each Academy having its own Council, Secretaries and President, and the President of each being in turn President of the whole Society.

"(3) The creation of two or of three 'Sections' of the Royal Society, either A and B, corresponding to the Academies just named ; or A, Mathematical and Physical Sciences ; B, Biological Sciences ; C, Philosophico-Historical Sciences.

"(4) The election of some 25 to 50 Fellows representing the Philosophico-Historical subjects, to serve as a nucleus, and the creation of three or four committees, similar to those already existing, viz., one for Ethnography and Archæology, one for Philology, one for Statistics and Political Economy, and one for Psychology, the Officers and Council remaining, so far as statute and enactment are concerned, precisely as they are at present."

After these schemes had been formulated they were discussed at an interview with a number of representatives of the philosophico-historical sciences. Concerning this interview we read :—

"They all expressed themselves in favour of any effort for the corporate representation of those sciences being associated in some way or other with the Royal Society. They seemed unanimous in feeling the great desirability of the organisation and official representation of the Philosophico-Historical subjects, both on the ground of the general encouragement of their pursuit, and also, and more especially, as a means of developing the more scientific methods of treating those subjects.

"The general opinion of these gentlemen upon the practical courses discussed in the Report seemed to be in favour of the plan numbered (3) in the Report, but, recognising the practical difficulties in the way of carrying out any such scheme immediately, they were generally in favour of an effort being made on the lines laid down in plan numbered (4) as a beginning, in the belief that should its adoption lead, as they believe it would, to greater activity in this country in the studies in question, there might ultimately develop out of it some more formal organisation, such as is contemplated in the other plans submitted."

It is frankly stated that the Committee were much impressed by the concurrence of opinion among the gentlemen whom they consulted and by the high value they set on the inclusion within the scope of the Royal Society's action of the subjects they represented.

After the Report of this Committee was sent in to the Council, a special meeting of the Society was called for May 9, 1901. Unfortunately there is no record of what took place at it, but at the Council meeting in June the following resolution was passed:—"That the Council, while sympathising with the desire to secure corporate organisation for the exact literary studies considered in the Report, is of opinion that it is undesirable that the Royal Society should itself initiate the establishment of a British Academy."

The *Times* now tells us that on June 28, 1901, a month after this resolution was arrived at, those interested in the proper representation of the "literary" subjects met at the British Museum and

"after long and careful deliberation resolved to promote the establishment of a British Academy of Historical, Philosophical and Philological Studies on conditions which would satisfy the requirements of the International Association of Academies. It was further decided that the Academy should petition for incorporation by Royal

Charter, and that the nomination of the first Fellows under the proposed charter should be forthwith taken in hand. Before the close of last year, on December 17, the British Academy held its first meeting at the British Museum and petitioned His Majesty for incorporation by Charter."

According to the draft Charter, the petitioners will be the first Fellows of the Academy, and the President and Council will be elected by the Fellows from amongst their own number. New Fellows will be elected at a general meeting of the Fellows.

The announcement in the *London Gazette* states that His Majesty has referred the petition to a committee of the Lords of the Council. Notice is further given that all petitions for or against such grant should be sent to the Privy Council Office on or before February 14 next.

The following letter from Sir Norman Lockyer appears in the *Times* of yesterday (January 29):—

SIR,—All students of natural knowledge in this country should agree as to the importance of the step recently taken to organise certain branches of it, concerning which you have given your readers much information. There are, however, some points connected with the movement on which you have not yet touched. Will you permit me to refer to them and the conclusion to which they lead?

The petition to His Majesty for a charter to embrace the organisation of historical, philosophical and philological sciences was rendered necessary by the action of the council of the Royal Society, who declined to "initiate the establishment of a British Academy" dealing with these subjects. But, in the first instance, the desire of those interested in the movement was that the Royal Society might include in itself a section corresponding to the philosophico-historical and philological division of the Continental academies; it was not a question of establishing a British Academy.

To consider the matter in this form a committee of the Royal Society was appointed, and its report has recently been published. In this report we have the following reference to the subjects dealt with by the historical and philological sections of foreign academies:—

These subjects have, in England, hitherto remained unorganised—that is to say, the workers in each one of them have been brought into little or no relation with the workers in each of the others. Societies have been founded for the promotion of some of them, but these societies are not linked together by the membership of their leading members in one body of recognised authority and influence, such as the Royal Society provides for the investigators of various branches of mathematical, observational, and experimental science.

The advantages which the gathering into one body of the men most eminent in the subjects above specified have secured in Germany, France, Italy and Belgium do not exist here, and the absence of any effort to secure them has often excited the surprise of learned men in those countries. Neither is there in England any series of Transactions similar to those of the leading academies of Continental Europe, in which records of the most fruitful inquiries in those subjects, or even systematised references to such inquiries, may be found.

We are next told that the following reasons, among others, have been suggested by eminent men as making it desirable that the Royal Society should take action in the matter:—

Assuming the organisation of the above subjects to be called for in the general interest of the intellectual progress of the country, the Royal Society can promote their organisation more effectively than could be done by the persons who are occupied in the study of them, because these persons have no sort of combined corporate existence, and no voluntary group of them would appear to have a proper *locus standi* for appealing to the public or approaching the Government in order to attain the object sought.

It has been urged on general grounds that the inclusion by the Royal Society of a section corresponding to the philosophico-historical and philological divisions of the German academies would strengthen the society by broadening the range of its scientific activity and increasing its influence; and would be to its advantage inasmuch as such a course would anticipate and thereby make needless the formation of an association which, by gathering the subjects within its scope, might to that extent be in rivalry with the Royal Society, and tend to narrow the legitimate range of its activity.

And next comes the most important part of the report, indicating that in the past, and by the three charters granted by His Majesty Charles II., the subjects under discussion were, and should now be, held to refer to "natural knowledge," and, therefore, should be dealt with by the Royal Society:—

The society exists for the promotion of natural knowledge. The interpretation of the term "natural knowledge," according to the present practice of the Royal Society, assigns to it a range from mathematics to the various biological sciences, and this secures the inclusion of the scientific study of man in his biological relations. . .

It is evident that the charters have never been interpreted as confining the "studies" of the society to "further promoting by the authority of experiments the science of natural things and of useful arts" in the strict modern meaning of those words. Indeed, the second charter in terms empowers the society to hold meetings "for the examination and investigation of experiments and of natural things," and both charters authorise it to enjoy "mutual intelligence and affairs with all and all manner of foreigners" . . . "in matters or things philosophical, mathematical, or mechanical." The provisions of the first statutes that the business of the society at its meetings shall be "to order, take account, consider, and discourse of philosophical experiments and observations; to read, hear, and discourse upon letters, reports, and other papers containing philosophical matters; and also to view and discourse upon rarities of nature and art," and the long and uninterrupted usage to receive papers on observational sciences, such as geology, or on pure mathematics, certainly do establish a *contemporanea expositio* which must be taken into account as *optimus interpres* and *fortissima in lege*.

Even had papers upon philological, psychological, or other subjects been entirely absent, no stress could be laid upon that fact, if in the opinion of the society those subjects have, under modern methods of treatment, become observational sciences, and as fully parts of "natural knowledge" as those subjects which were recognised as such at the epoch of the foundation of the society.

It would clearly be *ultra vires* for the society to resolve to receive a new class of papers, incapable of being regarded either in subject-matter or in scientific treatment as in the same category as those which have hitherto been received. But it would not be unlawful for the society to determine to receive papers on subjects not hitherto regarded as properly within its scope if it came deliberately to the conclusion that, in view of the scientific method in which they were now being treated, those subjects ought not to be excluded from its study.

The committee was not content with expressing its own view on this important matter; it privately consulted two high legal authorities, whose opinion led the committee to believe, in confirmation of the views above stated, that the inclusion within the scope of the society of such subjects as have been referred to, if treated by scientific methods, is "within the powers of the society."

Two extracts from the first charter granted by Charles II. alone seem to establish this conclusion. The charter begins as follows (I give the English translation as it runs in the "Record of the Royal Society, 1897"):—

Charles II., by the grace of God King of England, Scotland, France, and Ireland, Defender of the Faith, &c., to all to whom these present Letters shall come, greeting.

We have long and fully resolved with Ourself to extend not only the boundaries of the Empire, but also the very arts and sciences. Therefore we look with favour upon all forms of

learning, but with particular grace we encourage philosophical studies, especially those which by actual experiment attempt either to shape out a new philosophy or to perfect the old. In order, therefore, that such studies, which have not hitherto been sufficiently brilliant in any part of the world, may shine conspicuously amongst our people, and that at length the whole world of letters may always recognise us not only as the Defender of the Faith, but also as the universal lover and patron of every kind of truth: Know ye, &c.

Of the "Fellows" we read later on:—

The more eminently they are distinguished for the study of every kind of learning and good letters, the more ardently they desire to promote the honour, studies, and advantage of this Society . . . the more we wish them to be especially deemed fitting and worthy of being admitted into the number of the Fellows of the same Society.

"Every kind of learning and good letters" seems to me pretty general, and it does not seem improper to take the words "philosophical studies," in connection with Bacon's definition of philosophy, as dealing with a threefold division, of matters divine (supernatural), natural, and human, which also, perhaps, explains the subsequent insistence upon natural, as opposed to supernatural, knowledge.

But, without labouring this point further, I suggest that subjects the study of which by scientific methods increases the sum of natural knowledge must all stand on the same footing. I use the word "scientific" in its widest, which I believe to be the truest, sense, as including all additions to natural knowledge got by investigation. Human history and development are as important to mankind as the history and development of fishes. The Royal Society now practically neglects the one and encourages the other.

It is possible, then, to say the least, that the present general action of the society, and I say general, because the action changes from time to time, is really not in accordance with its charters; it certainly is not with its first practice. The charters make the society the head centre of the intellect of the kingdom engaged in making new natural knowledge, and therefore until these charters of King Charles II. are abrogated or revised there is no place logically for a new charter by King Edward VII. giving power to a new body to deal with the subjects the duty of the organisation and encouragement of which was previously committed to the Royal Society.

There can be no question that the gradual departure of the action of the Royal Society from the course laid down in the charters, and actually followed for a time, has been the gradual expansion and increased importance of experimental and observational methods of work, which of themselves are sufficient to employ the existing administrative machinery. But, if the whole work cannot be done inside the society as it exists at present, the question arises, Cannot some be organised side by side with it? Here, again, there may be difficulties; but, as the committee wisely say with regard to the first proposal:—

We are far from intending to express an opinion that any difficulties of detail ought to prevent the important issues involved from being fully considered in their largest bearings, having regard to the great benefits which might be expected to result to the progress of the philosophico-historical studies, and possibly to the Royal Society itself, from the inclusion of those studies within the scope of the society's action.

It is right that I should say that the Royal Society Council, in the resolution from which I have already quoted, expresses sympathy with the desire to secure a proper representation of the subjects now in question, and did not refuse to include them within itself, although its action may give colour to the belief in such an effect.

At present the Royal Society is the unique recognised centre of the general scientific activity in this country.

Will it be conducive to the interests of science, or even of the Royal Society itself, that in future there should be two entirely separate centres?

But will not this state of things be brought about if, without any general consideration, a charter is at once granted to the new body?

The important thing to secure is that the two bodies dealing with the two great groups of scientific subjects shall form part of one organisation—some enlarged Royal Society. What the *nexus* shall be is a matter of such subordinate importance that I do not propose now to refer to it further.

May not this present difficulty, Sir, be really a blessing in disguise? Does it not merely emphasise the activity of the scientific spirit and the employment of the scientific method in new regions, and suggest that the time has arrived, at the beginning of a new century and a new reign, for doing for the science of to-day what Charles II. did for the science of the seventeenth century—that is, organising and coordinating it on a broad basis?

It is clear that the question so wisely referred by His Majesty Edward VII. to the Privy Council is no light one, for the acts of a previous King of England and the future development of British science are involved. The present confusion is great and will become greater if a new charter is granted without a comparison and possible revision of the existing ones; and, short of an inquiry, by a Royal Commission or by some other means, to consider the question, it is difficult to see how the proper organisation of natural knowledge in the future can be secured.

It is fortunate that there is ample time for this important matter to be considered carefully in all its bearings, for not till 1904 can any British representation of the philosophico-historical subjects be considered by the International Association of Academies.

May I finally be permitted to say, Sir, how entirely I agree with the remarks in the leading article in the *Times* of the 16th inst. concerning the importance of organising literature as well as science? Science has undoubtedly gained by the charters of Charles II., and on this ground alone it may be urged that literature will be a gainer if it also is similarly organised. Certainly the most impressive sight I saw in Paris last year, when attending the first meeting of the International Association of Academies as a Royal Society delegate, was the reception of a new literary member of the Académie Française. The combination of troops representing the Government and members of other academies representing the Institute of France formed a picture which is not easily forgotten; it was one also to set one thinking.

I am, Sir, your obedient servant,

NORMAN LOCKYER.

THE EIFFEL TOWER.

La Tour Eiffel en 1900. Par M. G. Eiffel, Officier de la Légion d'Honneur. Pp. 363. (Paris: Masson and Co., 1902.)

IN a handsome volume, profusely illustrated with engravings and photographs, M. Eiffel has given an elaborate account, from its earliest conception, of the lofty structure that will always bear his name, and of the mechanical devices which have secured its success, both as a worthy monument of the art of construction and as a source of delight to the millions who have ascended it. We understand and regret that this monograph in some measure owes its appearance to the attacks of detractors, and it is intended to furnish a complete answer to those who, disapproving of the structure, have commented on its puerility and its uselessness. This ill will, well pronounced in the early days of the structure, and to which

M. Eiffel refers at length, has possibly revived since the falling off of receipts on the occasion of the last exhibition, and the well-earned reputation of the author may have suffered in consequence. Certainly no less than three descriptions of the Tower have emanated from the eminent engineer in a short space of time. The first, entitled "La Tour de trois cents Mètres," was an *ouvrage de luxe*, a massive folio volume with sixty-seven plates, also in folio. This work, intended for experts, has been presented to various public libraries and scientific societies, and will be consulted with interest by those engaged in similar projects of construction. Next appeared, in a more handy form, "Travaux Scientifiques exécutés à la Tour de trois cents Mètres," which, though not generally circulated, was intended to form a complete refutation to those who still urged the plea of inutility against the structure. The present volume appears to follow a middle course between these two, the author giving an account of the history of the construction of the Tower, the modifications that were suggested, after the experience gained in 1889, to make it more accessible to visitors in 1900, together with some account of the scientific investigations which this unique structure rendered possible or facilitated by reason of its height and form.

We have here, therefore, a complete history of the building from the date of its proposal in 1886 up to the present time, and of necessity many of the details have already appeared in the public journals, while the authors of the scientific work that has been carried on in connection with it, having contributed their results to various scientific bodies, have had them published in due course, and these have been commented on in our columns from time to time. As an example, one may refer to M. Janssen's researches on the telluric origin of the lines of oxygen in the solar spectrum, which were carried out in 1889. The value of the book consists in the completeness of the historical details and the ready access it offers to much that has been accomplished in connection with the Tower, particularly in the way of meteorological observations. M. Eiffel naturally thinks it a complete answer to his detractors, but whether this be so or not, it is impossible not to recognise that the management has welcomed with loyalty and assistance every scientific project that has been recommended to its consideration. One gathers that in the view of the promoters, the Tower was never intended to be either a scientific laboratory or a judicious pecuniary investment. We may quote here M. Eiffel himself:—

"Il me semble que, n'eût elle pas d'autre raison d'être que de montrer que nous ne sommes pas simplement le pays des amuseurs, mais aussi celui des ingénieurs et des constructeurs qu'on appelle de toutes les régions du monde pour édifier les ponts, les viaducs, les gares et les grands monuments de l'industrie moderne, la Tour Eiffel mériterait d'être traitée avec consideration."

And again:—

"Étant la plus saisissante manifestation de l'art des constructions métalliques par lesquelles nos ingénieurs se sont illustrés en Europe, elle est une des formes les plus frappantes de notre génie national moderne."

Looked at from this point of view, its existence is its justification. It accomplished what was demanded of it, and its scientific applications, useful as some of them may be, are no more than an ornamental fringe to the main design.

In 1889 nearly two million visitors paid for admission or ascent, and the lifting apparatus had been taxed to the extent of carrying 23,000 persons in a day. With the view of offering greater accommodation on the occasion of the exhibition in 1900, when as great or greater numbers of visitors might be expected, it was determined to increase the accommodation on the various platforms and to rearrange the mechanism of the lifts so that a greater number of ascents could be made per hour. The alterations, necessarily of a costly character, are described in very great detail, and when completed provided for the partial or complete ascent of 3120 passengers per hour, instead of 2680 per hour, as in 1889. Or regarded from another point of view, while the total receipts under the old system could not exceed 5240 francs per hour, under the new arrangement, with a lower tariff, the hourly receipts could amount to 7120 francs per hour. A great deal of work had to be effected, and the manner of its accomplishment, interesting to experts, will be found set out with great clearness and precision. How the sanguine expectations were disappointed is a matter of history, and the falling off in the number of visitors to about one-half is to be regretted; but the efficiency of the arrangements and the success with which they worked should be a matter of congratulation from an engineering point of view.

Having disposed of these mechanical arrangements, to which are added some interesting statistics connected with the financial side of the question, M. Eiffel gives some account of the various scientific purposes to which the Tower has been put during the last eleven years. These, referring to meteorology, to atmospheric electricity, to the construction of a manometer for high pressures, and a variety of other researches, have been mentioned in these columns at the time the different physicists engaged in the work published the results of their investigation. Although mention has already been made of wind observations in connection with the Tower, notably in vol. xlix. p. 596, and li. p. 181, we are tempted to return to this question and give the results of a simple investigation conducted by M. Eiffel to detect the amount of motion that the structure experienced under the influence of a high wind. It will be remembered that the opponents to the scheme of construction in the early days made a strong point of the difficulties that would ensue from excessive wind pressure, and the point is interesting, not only on that account, but because a great deal of loose information is current concerning the motion of tall chimneys and steeples. Anemometry, when applied to considerable areas, is not in a very satisfactory condition, and the necessary strength to be given to buildings is more or less a matter of conjecture and experience. M. Eiffel's method of observation was exceedingly simple. On the third platform, at a height of 309 m., was placed a diagram of concentric circles alternately coloured white and red, each 20 mm. in breadth, and ten in number. The centre of this target, if it may be so described, was made to coincide with the intersection of the cross wires of a solidly mounted theodolite at the base of the eastern pillar. It seems to have been assumed that the telescope

would not move, and the observation was effected by noticing the circle on the diagram which came under the intersection of the cross wires. It is not very clear how the motion in the line of sight was measured, or how the effects of foreshortening were removed. There was no illumination, and the observations were confined to daylight. The general effect of the wind is to make the top of the Tower describe an ellipse, and several diagrams are reproduced showing the effect of the greatest storms. The maximum displacement occurred during the storm of December 20, 1893, when the major axis of the ellipse was 0·10 m., and the minor axis 0·06 m. The time occupied in the description of the ellipse would have been interesting, but is not given. The measured velocity of the wind at the moment of observation is recorded as 31·8 m. per second, or 71 miles per hour. During this storm a velocity of 44 m. per second, or 98 miles per hour, was recorded, but at that moment the major axis of the ellipse was only 0·06 m. This seems to have occasioned M. Eiffel some surprise, but fortunately these excessive gusts are generally operative over a very small area, and the total wind force on the Tower is not to be measured by that experienced at a point very near the anemometer. The same apparatus has served for the measurement of the effects of temperature. The curves traced are generally of a complex character, depending on the position of the sun, and consist mainly of small excursions into the north-west and west quadrants. An example is given of the motion on a very hot day in August, when the centre of the diagram practically traced an elongated ellipse, 24 cm. in length, parallel to the east and west direction.

The researches summarised in the volume appear to be rather unequal in value, and a very small connection with the Tower affords a sufficient warranty for their introduction. Thus we get some account of the recent balloon ascent of M. Santos Dumont, because it was a part of the scheme for testing the capacity of giving definite direction to such an apparatus that the Eiffel Tower should be included in the closed curve to be described by the aëronaut. Perhaps, however, one underestimates the part played by the Tower in this instance, for M. Emmanuel Aimé, slightly changing the well-known aphorism of Voltaire, assures us if the Tower did not exist it would be necessary to invent it for the necessities of aërostation. It seems, however, that M. Dumont prefers to pursue his experiments where he gets no assistance from the lofty structure. This tendency to stray from the subject is still more noticeable in the appendix, where we get a chapter "renfermant une notice sur les travaux exécutées par mes établissements industriels de 1867 à 1890." We have no desire to quarrel with M. Eiffel on this ground. He has carried out many great and difficult works in various parts of the world, and is to be congratulated on the success that has generally attended them. In forming our estimate of what he has accomplished for engineering science he should not be judged simply by the most popular or conspicuous example of his talent, but by the work of his whole career, which he may contemplate with complete satisfaction.

VOIGT'S ELEMENTARY MECHANICS.

Elementare Mechanik als Einleitung in das Studium der theoretischen Physik. Von W. Voigt. Zweite umgearbeitete Auflage. Pp. x + 578. (Leipzig: Veit, 1901.) Price Mk. 14.

THE object of this book is to provide the student of physics with a working knowledge of theoretical mechanics. With this view the reader is introduced successively to dynamics of a particle, dynamics of rigid bodies, attractions, hydrodynamics, elasticity; in each department statics holds a subordinate position, equilibrium being treated as a particular case. The design of presenting, within the compass of a volume of moderate size, an account of the things that are fundamental in the mechanics of bodies, whether solid or fluid, rigid or deformable, is entirely laudable. It brings into prominence the essential unity of subjects which are frequently treated as independent of one another; it imposes a selection of the topics to be discussed, and thus results in the elimination of much that is artificial and conventional though sanctioned by tradition.

A critical discussion of the principles of mechanics would perhaps have been out of place in a work of this character; at any rate it is not attempted by the author. His standpoint, so far as it is indicated, would appear to be nearer to that of Thomson and Tait's "Natural Philosophy" than to that of Kirchhoff's "Vorlesungen über mathematische Physik, Mechanik." As regards methods, it is noteworthy that the author makes comparatively little use of the conception of energy, and that he does not introduce Lagrange's equations. Accordingly, the stability of floating bodies is discussed geometrically after the manner of Dupin, and the small oscillations of a system with a finite number of degrees of freedom are not discussed at all. On the other hand, space is found for an account of "vector fields" and "tensor fields." The distribution of velocity in a fluid affords an example of a vector field, the distribution of strain in a body affords an example of a tensor field; with a vector field there is associated at each point a directed linear segment, with a tensor field there is associated at each point a certain surface of the second degree. Most recent continental writings on physical mathematics treat of vector fields. The chapter devoted to the dynamics of rigid bodies is made unusually interesting by the use of the theories of several pieces of apparatus—the balance, bifilar suspension, Atwood's machine, Foucault's pendulum—as illustrations of the mode of formation and solution of equations of equilibrium or motion the theory of the application of the pendulum to the determination of the acceleration due to gravity is also given. The treatment of rolling friction, of which two accounts, apparently conflicting with each other, are given in two separate articles, leaves something to be desired. An excellent feature of the book is the emphasis laid on the "dimensions" of physical quantities; no quantity is introduced without an explicit statement of its dimensions in terms of the units of mass, length and time.

The plan and purpose of the book require that the reader should not be assumed to possess a knowledge

of the theory of partial differential equations. This restriction renders necessary some originality of method in problems relating to fluid motion and to the equilibrium and motion of elastic solids. The book should prove very useful to teachers, by showing how much of these theories can be treated adequately by the aid of simple analysis. Perhaps the most remarkable piece of work, among those designed to make the theories of mathematical physics accessible to readers whose mathematical equipment is not very large, is the discussion of the equation of transverse vibrations of a stretched string; the writer founds the theory of this equation on a geometrical method, which was initiated by Riemann in his memoir on the propagation of plane sound waves of finite amplitude. The portion of the book dealing with deformable bodies contains, among other things, a very interesting account of *stress*; the notion of stress is introduced by means of a preliminary statement in regard to the observed character of the interactions between the smallest parts of bodies. Observation seems to be credited here with proving things which must, from the nature of the case, be remote inferences from observation. The subsequent deductive investigation is very well done. Viscosity in fluids receives a good deal of attention, and the divergences between the motions and resistances of perfect and of viscous fluids are illustrated by comparing the two solutions of the problem of the steady motion of a sphere through a fluid, regarded first as perfect and then as viscous, and by the contrast between the diffusion of vorticity in a viscous fluid and the permanence of vortex motion in a perfect fluid. Although it might be wished that the treatment of the fundamental theorem of rational hydrodynamics had been less summary, yet it will be felt that the student of theoretical physics owes a debt of gratitude to Dr. Voigt for his clear outline of the theories of fluid motion.

A. E. H. L.

ESSAYS ON BIRD-LIFE.

Birds and Man. By W. H. Hudson. Pp. 317. (London: Longmans, Green and Co., 1901.) Price 6*s*. net.

THE author of "The Naturalist in La Plata" is such a close and accurate observer of nature, and has such a rich store of anecdote upon which to draw, while his style is so fresh and invigorating, that a hearty welcome from the public is well-nigh sure to await all the efforts of his pen. In this little volume he has given us a delightful series of essays dealing with bird-life in England, in the course of which he dwells specially on the relations between bird and man as they exist in nature. Many of these essays have previously appeared in various serials, but a very considerable portion of the book, including the introductory chapter, is new.

Mr. Hudson has such an enthusiastic love for bird-life that, as he tells us in this introductory chapter, the sight of stuffed birds in a museum is positively painful to him. If this be so, an obvious and easy course lies before him, and it is unnecessary on his part to say that collections of this nature "help no one, and their effect is confusing and in many ways injurious to the mind, especially to the young." No one, of course, wishes to argue that stuffed birds are as good as living ones, but since the great majority of us have neither opportunity, time, patience nor money to devote to the observation of birds in their native haunts, we may surely be permitted, if we please, to study and admire their counterfeit presentments in a museum.

Perhaps the most interesting chapter in the book is the second, which bears the same title as the book itself. Here the author tries to imagine what birds think of man. At times, he thinks, they must be considerably puzzled, as when a blackbird is petted while on its nest by the owner of a garden, only to be shot at or stoned when it leaves the protected precincts.

"Birds" (says the author) "are able sometimes to discriminate between protectors and persecutors, but seldom very well, I should imagine; they do not view the face only, but the whole form, and our frequent change of dress must make it difficult for them to distinguish those they know and trust from strangers. Even a dog is occasionally at fault when his master, last seen in black and grey suit, reappears in straw hat and flannels."

Later on it is shown how birds clearly discriminate between dangerous and harmless mammals, the author giving us many interesting anecdotes derived from his Argentine experiences of the relations between birds and mammals in the wild state.

Several of the chapters—notably the one on the Dartford warbler—are devoted entirely to British birds, but in others the author takes a wider field. Among these latter the article on geese, with its description of the vast throngs of the Magellanic and upland species to be seen at certain seasons in Argentina, is of especial interest. It closes with a pathetic anecdote of a pair of these birds, which, on account of the female having a broken wing, started to *walk* the long journey from the pampas of La Plata to distant Patagonia.

In the two concluding chapters the author gives some supplementary notes on the birds of London, and describes his impressions on first visiting Selborne in 1896. In taking leave of this charming book we have two regrets—one that it is not longer, and the other that we have not space for a fuller notice.

R. L.

OUR BOOK SHELF.

The Earth's Beginning. By Sir Robert S. Ball, LL.D., F.R.S. Pp. viii + 384. (London: Cassell and Co., Ltd., 1901.) Price 7*s*. 6*d*.

THIS is a popular account of the nebular hypothesis, based upon a course of lectures adapted to a juvenile audience, and it is, therefore, almost superfluous to remark that the subject is presented in simple language and that no great mental effort on the part of the reader is called for. The theme is one which furnishes splendid opportunities for the display of the powers of graphic description and illustration for which the author is so well known, and the book will doubtless succeed in extending the interest in this fascinating chapter of science.

From the demonstration of the existence of true nebulæ, the reader is gradually led to the evidence that the sun and earth once existed in nebulous form, and thence to see how the present conditions of the solar system accord with the hypothesis. The difficulty presented by the anomalous revolutions of the satellites of Uranus and Neptune is got over ingeniously by supposing that in these cases the concordant stage of the evolutionary pro-

cess has not yet been reached. While the application of the theory to the solar system is kept mainly in view, the evidence of its truth afforded by observations further afield is by no means neglected; but no attempt is made to trace the story of celestial evolution generally, or to state the various stellar stages through which the sun itself must have passed. Thus, for the most part, only familiar ground is traversed, and the chief value of the book as a contribution to the literature of the subject lies in the clearness of exposition and wealth of illustration.

The maintenance of the sun's heat and the principle of the conservation of moment of momentum are treated in a specially lucid manner, and the appendices dealing more fully with these questions greatly enhance the value of the book to students.

Objection might be made to the use of the term "fire mist" as applied to the original nebula, since it was not necessarily an incandescent mass, and consequently also to the extension of the theory which attributes this nebula to the collision of two dark bodies. As a minor objection, the view that the sun's photosphere is composed of particles of carbon cannot yet be regarded as the demonstrated fact which the author seems to suppose. A curious error, occurring on p. 277, may also be mentioned; it is stated that the discovery of helium in the sun in 1868 was made during an eclipse, whereas the main point of the observation to which reference is made was that it was made without an eclipse.

There are numerous excellent illustrations, many of them from photographs; but the descriptions are in some cases quite inadequate. Thus, Figs. 43, 44 and 54 will only be intelligible to those who have a fair acquaintance with astronomical spectroscopy, and the numerous photographs of nebulæ appear to have been distributed almost at random.

Monograph of the Coccidae of the British Isles. By Robert Newstead. Vol. i. Pp. xii + 220. Plates A–E, 1–34. (London: Ray Society.)

THE Coccidæ, or scale-insects, are of great importance horticulturally and economically, for although some species yield important products, such as lac and cochineal, others are among the most destructive pests of our orchards and gardens, being peculiarly injurious to plants grown under glass. Mr. Newstead, himself a practical gardener, has devoted many years to their study, and has given us the results of his painstaking investigations in the present work. He admits about ninety species and varieties of Coccidæ as occurring in the British Islands, belonging to eight of the twelve subfamilies at present recognised, the other four being at present unrepresented in Britain. The systematic part of the first volume deals only with the first subfamily, the Diaspinæ, to which Mr. Newstead refers eleven genera and thirty-seven species. A very full introduction is prefixed to the volume, dealing with the structure and habits, parasites, enemies, &c., of the Coccidæ, and practical observations on the best means of coping with their ravages, and full directions for collecting and preserving. Among the most original of the author's observations are those relating to birds as destroyers of Coccidæ.

Till recently the Coccidæ have been one of the families of insects most neglected by British entomologists, and Mr. Newstead's admirable monograph adds another to the important series of works on neglected groups of insects for which we are indebted to the Ray Society. There is still, however, much work to be done before our knowledge of the insects of the British Islands can be considered to be anything like complete, especially, perhaps, among the parasitic Hymenoptera, which have been strangely neglected by most entomologists, notwithstanding their vast number and variety, their beauty, and their economic importance in keeping down the numbers of all kinds of insect pests. This neglect may perhaps be accounted for, however, by the small size of the great majority of the species, many of which, including some of the most curious and beautiful, are among the smallest insects known. But we hope to see these and other neglected groups of insects gradually worked out, on similar lines to those followed by Mr. Newstead in the present work.

Le Sel, les Salines et les Marais Salants. Par A. Larbalétrier, Professeur a l'Ecole d'Agriculture de Grand-Jouan. Pp. 166. (Paris: Masson et Cie; Gauthier Villars. No date.)

THIS volume is one of the "Encyclopédie Scientifique des Aide-Mémoire," a title which sufficiently expresses its scope. After a brief description of chlorine, sodium and the properties of sodium chloride, the methods of production of salt from sea-water on the coast of France are described, followed by short accounts of the treatment of the mother liquors of crystallisation for bromine, of the principal European salt mines, of the production of salt from saline springs, and of the Stassfurt deposits. The book concludes with a description of the impurities and analysis of salt, statistics of production in various countries, and of the use of salt in food, agriculture and medicine, and, lastly, a bibliography—perhaps the most important part in a work which is chiefly a compilation of facts obtained from other sources.

An encyclopedic article of this description, published in a handy form, will be useful provided the data given can be relied upon. Unfortunately, in this instance this is not always the case; a number of misprints occur in the figures in the tables, misstatements are made in the chemical details, and names of places are misspelt. On the other hand, the methods of mining salt in the principal European mines and the production of salt from sea-water and saline springs in France are adequately described, and the book is written in a readable form, sufficiently illustrated and well printed.

T. S. D.

Elementary Ophthalmic Optics, including Ophthalmoscopy and Retinoscopy. By J. H. Parsons. Pp. 162. (London: J. and A. Churchill, 1901.) Price 6*s*. 6*d*.

A SOUND statement of the optical principles involved in ophthalmology, which nevertheless does not require a knowledge of higher mathematics, and which is confined within reasonable limits, has no doubt been long sought by students of this special branch of surgery, and in "Elementary Ophthalmic Optics," now under notice, they will find a trustworthy exposition of the laws affecting the refraction of the eye. The book is well printed and the diagrams are large and clear; it seems a pity, perhaps, that the author was not bold enough to depart from the conventional letters used in optical formulæ, which, such as f, f_1, f_1', f_2', become liable to confusion, though it is difficult to suggest better symbols offhand.

The student should have been warned that the equation $l_1 l_2 = F^2$ (p. 14), if applied in the case of parallel rays proceeding from infinity, becomes indeterminate. The equations proved in chapters iv. and v. become exceedingly wearisome, important though they are, but a few illustrations of their application at the time would relieve the monotony, which might frighten the more practical man from continuing his reading to the later portions of the book, where their results are made use of and where stress is laid on several most important points not usually explained or mentioned in works on ophthalmology. It is not altogether clear where all the distances given for Listing's schematic eye are measured from; also in an earlier and a later page the foci of the aphakic eye are given differently, leading to confusion in the mind of a careful reader. Chapter vii. brings into prominence some very essential facts in relation to the size of the image formed in the ametropic eye and the effect of spectacles

and their position thereon. The proofs here given should serve to elucidate some of the puzzling cases not infrequently met with in testing errors of refraction. Chapter x., again, gives much valuable information on the use of the ophthalmoscope to the best advantage, and the difficulties of retinoscopy are sufficiently dealt with in the last chapter. There is no mention of accommodation or presbyopia, several points in which might well have been touched upon. An index would have been of assistance in the search for any equation relating to a particular case.

The Process Year Book, 1901–2. Edited by William Gamble. Pp. xvi+152. (London: A. W. Penrose and Co., 1901.)

EVERY year we receive this admirable and beautiful book illustrating the present state of process work, and we cannot do better than again suggest that everyone interested in the art of picture reproduction should be the possessor of this volume. The illustrations and text still maintain their high standard of excellence, and the variety of the subjects and processes dealt with gives the reader a good insight into the manifold methods in photo-mechanical engraving and the allied arts and crafts.

It may, perhaps, be specially mentioned that in consequence of the great advance in the department of process work relating to the three-colour method the editor has introduced a variety of specimens such as perhaps never before has been collected together between the covers of a single book. A glance at these soon suffices to illustrate the high state of efficiency of the methods employed to-day; and one only wonders what the future has in store for us, since it is to this branch of process work that we look for the possibility of the greatest progress.

Nautical Astronomy. By J. H. Colvin, B.A. Pp. 127. (London: E. and F. N. Spon, Ltd., 1901.) Price 2*s*. 6*d*. net.

ONE of the greatest difficulties encountered in the study of spherical and nautical astronomy is to obtain a proper comprehension of the various circles of the celestial sphere, without which the solution of the problems involved can never be anything more than mechanical. The author of this book, however, has not thought it necessary to assist the student greatly in this direction, for fifty very brief definitions can by no means be regarded as an adequate introduction to celestial geometry. Thus, unless the student is endowed with an exceptionally good geometrical imagination, or has the advantage of a good teacher, it does not seem likely that he will be able to use the book with profit. The initial difficulties excepted, however, the book has many good features; the explanatory matter is brief and clear, and there is a useful collection of formulæ, rules, numerical illustrations and exercises to be worked out. Much space is saved by the omission of tables which do not vary, while specimen pages of the "Nautical Almanac," adapted to the exercises, have been introduced.

The book is designed to cover the elementary and advanced stages of the South Kensington syllabus, and also includes the course for "extra master" in the Board of Trade examination.

Elementary Chemical Theory. By G. H. Martin, M.A., F.C.S. Pp. 24. (London: Rivingtons, 1902). Price 9*d*.

THE only use to which this collection of didactic statements can be put is to furnish students of chemistry with material suitable for copying into their notebooks. It was scarcely worth while to attempt to extend the use of the book beyond the author's own pupils.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

Cherry Disease.

IN NATURE for January 9 (p. 239) there is a report of the meeting of the Royal Microscopical Society on December 18. The president, Mr. William Carruthers, F.R.S., made a communication with respect to the cherry disease which has appeared in Kent, from which I extract the following:—

"The results of experiments in the cultivation of the fungus showed it to be one which belonged to the genus Gnomonia. Many of the fungi in this class passed through various stages in their life-history, for example the mildew on wheat, which was first developed on the berberry and then spread to the wheat, appearing first as rust and afterwards as mildew from the same mycelium. The president referred to the absence in this country of any authority competent to investigate cases such as this; on the continent, however, the Governments had taken up the matter, and the experts who had inquired into it had found that to check the spread of the disease it was necessary to collect all the dead leaves and burn them."

Prof. A. W. Bennett followed in the same strain and "enlarged upon the absence in this country of investigations into such matters by State-paid establishments, and described what was being done in the United States, where every State had its own experimental station."

Now it is not my intention to discuss whether the Government does as much for scientific inquiry in the interests of the community as it might do. But it is clear to me that nothing is gained by overstating the case. There are two "State-paid" establishments devoted to botany in this country, Kew and the Botanical Department of the British Museum. Each happens to have upon its staff an officer trained in mycological investigation. And it may be added that Mr. Carruthers is himself consulting botanist to the Royal Agricultural Society.

So far as Kew is concerned, the matter was promptly dealt with in ordinary routine. Mr. Massee, who has charge of the cryptogamic collections, had given a brief account of the disease in his "Text-book of Plant Diseases," with a figure (pp. 110, 111), although at the time (1899), so far as I am aware, the disease had not been noticed in this country. Mr. A. O. Walker, of Maidstone, sent specimens in November, 1900. I quote the *Gardeners' Chronicle* for May 23, 1901 (p. 191), where he writes:—

"Early in November I sent specimens to Mr. G. Massee, of the Kew Herbarium, who reported to me that the leaves were affected by the fungus *Gnomonia erythrostoma*, and quoted Frank's opinion that the leaves should be gathered and burnt."

The council of the Royal Agricultural Society issued on February 6, 1901, a report by Mr. Carruthers giving the history of the disease and recommending Frank's remedy of burning the leaves. There is nothing very profound in this recommendation, as it is a general method applicable to all plant diseases propagated by spores, and aims at removing the source of infection.

As I recently pointed out in NATURE (vol. lxiv. p. 212), we owe to the late Prof. Cornu "the principle now so familiar as to seem almost obvious, of preventive treatment by the careful destruction by burning of the *débris* of plants which may harbour spores."

I may add that the Gnomonia is well known to mycologists, having, in fact, been first described by Persoon as a Sphæria a century ago, and there are in the Kew Herbarium specimens of it from no less than eight published collections. Mr. Carruthers in his report, which is reproduced in the *Journal* of the Royal Horticultural Society (n.s. xxv. pp. 313–316), does not give an illustration of the Gnomonia, but figures instead a "Fragment of Leaf of Cherry Tree showing groups of Parasitic Fungi." These belong, apparently, to a species of Phoma and, so far as I am aware, there is no evidence that they have anything to do with the Gnomonia.

There the matter stands, and for my part I entirely fail to see how "the authority competent to investigate cases such as this" of whom we are said to be in want, could carry it farther. The

disease has been known on the continent for the last twenty years, and notwithstanding that "Governments had taken up the matter," we are no wiser as to the life-history of the parasite than they were in Germany at starting. Nor if we were should we be probably any better off, however interesting the result might be from a scientific point of view. For each phase of such a fungus has apparently an indefinite capacity for propagating itself independently. The rust of wheat is as destructive in Australia as anywhere else, and is not checked by being unable to complete its life-history on the barberry.

It is not material, but it may be noted that Gnomonia belongs to a group of fungi widely remote from the rust of wheat. I can hardly believe that Mr. Carruthers intended to suggest that they belonged to the same "class."

But my object in drawing attention to the matter is to remonstrate with my scientific friends for the mistaken policy which it seems to me that many of them are too apt to adopt in matters of this kind. It is the fashion now to clamour for "State-paid" assistance for everything, with no sense of the relative importance of the objects aimed at or appreciation of the work which is actually being done. It is most important that Government aid should be obtained for a definite purpose, such as that of the National Physical Laboratory. But if scientific men will not even give the Government credit for the aid it gives, they run the risk of being regarded as impossible to satisfy.

In his report, published by the Royal Agricultural and Horticultural Societies, Mr. Carruthers states :—"The neglect of undertaking this operation (burning of the dead leaves), though costly, means the disappearance of the cherry orchards of Kent in a very few years." In the face of this very serious statement it is remarkable that, so far as I can ascertain, no information on the subject has reached the Board of Agriculture.

Kew, January 22. W. T. THISELTON-DYER.

Variation in Fowls.

EVERYONE who is acquainted with poultry must join Mr. Tegetmeier in deprecating the economic degradation of good old breeds by breeding for fancy points only (p. 152). But it is an ill wind that blows nobody good, and from a scientific point of view a decadent old breed with exaggerated points is more interesting than one of the comparatively useful modern mongrels produced by crossing, since the former shows conclusively what can be done by sheer selection, even though applied for a senseless end.

Fortunately, Mr. Tegetmeier has given excellent comparative views of some breeds before and after "improvement" in his work on "Table and Market Poultry"; but if the old strains are obtainable anywhere in their primitive form it would be, I think, very desirable to get specimens and preserve them, together with some modern highly-bred birds, for the benefit of bionomical students when the declining breeds have become extinct. Meanwhile, I should like to draw the attention of students of variation to the great differences observable in domestic fowls which have not been subjected to any selection, such as the ordinary poultry of India. Among these, although they are allowed to breed anyhow, may be seen all recognised colours of fowls except those of the highly specialised laced, pencilled and spangled breeds, which have needed a long course of selection. Double or "rose" as well as single combs occur, although the latter are a minority, and small crests are common. Five toes and feathered legs are rare; the legs vary much in tint.

Now, in Egypt, I have observed that, while equally variable in coloration, the fowls displayed some structural points peculiarly their own. The combs are very often *really* double; not the coral-like "rose" comb, but a bifid or two-flapped edition of the normal compressed and serrated form. The hind toe also was very often bifid, exhibiting every gradation from the five distinct toes of the Dorking to a distally split hind toe or one in which the normal hallux was represented by a mere terminal joint with a nail, growing from the long upper supernumerary hallux. Indeed, I even got a specimen in which the extra hallux alone remained, the true first digit having disappeared altogether! The consequence was that this bird's foot looked like a curassow's, but I observed that it had very little power of grasping therewith.

In Zanzibar I again found poultry of every colour, but very true to the lanky, close-feathered, small-combed Malay or Chittagong type, which thus seems to maintain itself in spite of neglect by breeders.

What is particularly noticeable in casually-bred poultry is the correctness of some of the types of marking. Thus the silver-grey variation, in the cock, resembles the typical black-breasted red in everything except in that the red parts of the plumage are changed to white. The corresponding hen has the brown and yellow of the upper surface also replaced by white, and hence is grey in tone with a silver-streaked hackle.

When such correlated grey and rufous forms occur in wild gallinaceous birds, they are put down as climatic variations, but it is obvious that climate cannot be the *direct* cause, though it may favour the survival of one type rather than the other, according to constitution or surroundings.

Another common style of marking found in two colours is that in which the base of the neck, the primary quills and the tail are chiefly black in both sexes, the rest of the body being uniform, either white or some rufous shade ranging from bay to buff. This coloration might easily characterise a natural species, although it is not known to do so; in accepted breeds the white form has been adopted as the proper colour for the light brahma, and the cock of the golden-pencilled Hamburg breed closely approximates to the black-tailed rufous form. Hens of the black-tailed red type are, however, not recognised in any breed.

A very common and curious variation in rough-bred fowls is the "wheaten" hen. This bird is of the pale-brown colour of wheat, with a dark-brown neck and black tail; but the correlated cock is a black-breasted red of the jungle-fowl colour. This colour of the hen is recognised in Malays and old English game, and is said to breed the brightest cocks.

It has occurred to me that the occurrence of two such distinct types of hens as the "wheaten" and the "partridge" (the name given to hens of the jungle-fowl brown) in correlation with similarly coloured cocks may, perhaps, help to explain the phenomenon of dimorphism in female butterflies. For if we knew the pedigree of these insects as well as fanciers do that of their fowls we might very possibly find that in dimorphic species two strains with dissimilar females but similar males existed and interbred.

So, also, the great and sudden variations throw light on the origin of mimicry. The form of the fowl with white body and black quills and tail, above alluded to, is similar in plan of coloration to several large and powerful birds. If such a variation occurred where the form and flight were favourable to mimicry, as it might easily do among the multitudes of passerine birds, we should have mimics ready-made.

The problem in the case of butterflies is much easier, owing to their greater general similarity of shape; but in any case it is obvious that variation is more important than selection here.

Indian Museum, Calcutta. F. FINN.

Elementary School Mathematics.

THE appointment of a committee of the British Association on the teaching of elementary mathematics encourages the hope that that body will be able, after collecting the opinions of practical educators, to focus them with due wisdom into a scheme which will be generally acceptable, both to teachers and examiners. For success to be attained it is obviously necessary that those who are in actual touch with the work of teaching should state what, in their judgment, is desirable and practicable. Hoping that others besides myself will follow the example set some time ago by Mr. Hurst of Eton, I venture to write to NATURE a sketch of the conclusions to which an experience of many years at Charterhouse has led me.

I have in mind in what follows the needs of the average boy, not of that comparatively rare individual who has some real mathematical taste; but I am sure that the progress of the latter is at present often sadly retarded by the course of study through which he is put. Our public schools have, unhappily, as I think, no organisation for securing common action except the annual conference of head-masters, which has, so far, done very little for the cause of education, hence methods and ideals vary much; but I shall assume that the average character of what is taught may be gathered from the papers set in the various public examinations for which we all prepare, and from the most popular text-books in use. Taking this ground, I think the broad indictment must be at once admitted that school mathematics are altogether too abstract and

artificial; aiming at training the pure reason they have got out of touch with facts, and for many pupils degenerated into mere jugglery with symbols cast loose from thought; hence they fail to interest and influence all but a very few. Look at the questions set in any of the well-known examinations—and see how many of them consist of stock puzzles of more or less complexity, invented, apparently, solely in order that successive generations of boys may learn how to deal with them, score marks by them, and then lay them aside as useless! And, of course, a large portion of our text-books and our teaching is necessarily devoted to such questions. So long as the chief examinations maintain their present character a general reform of school mathematics is well-nigh impossible, and partial reforms at individual schools (I have Winchester in mind as a pioneer in endeavour) are very difficult. I will, however, briefly and without detail indicate directions in which I think real improvement can be made without introducing revolutionary changes.

The great aim must be to introduce as much as possible the concrete element, for there are few boys who cannot be interested keenly in what they can deal with in practical fashion by drawing or handling in any other way, and fewer still to whom a bare abstract idea is not repellent. Until elementary physical measurements and the mathematics appropriate for dealing with them are taught together, an arrangement much to be wished for both from the points of view of science and mathematics, the best field for the introduction of the concrete is undoubtedly geometry.

In all the earlier stages of geometrical work, theory should always be kept in touch with practice by much drawing and measuring of figures; this, I am convinced, is the best way of building up exact geometrical ideas, and it has besides the great advantage of being intensely interesting to boys. I do not refer to "geometrical drawing" as often taught and usually understood in examinations which aims merely at making certain constructions (though this gives a valuable bit of training to those who have too often no notion of using their hands efficiently for any purpose not connected with a ball), but I would have it used always concurrently with, and in illustration of, demonstrative geometry. This is, I know, quite possible, though I have as yet come across no text-book in which it is done.

In theoretical geometry the only serious divergences from Euclid's methods I would advocate are (1) the introduction from the first of the idea of an angle as generated by a rotation, and (2) the substitution of the arithmetical and algebraical treatment of proportion for Euclid's.

Euclid's test of proportion, which appeals so strongly to the grown mathematician by its elegance and completeness, is for even the very best boys very difficult to grasp, and for the moderate boy a rigid insistence on it (which is practically never made) would involve an absolute bar to the discussion of similar figures and elementary trigonometry, matters which are quite easy if the difficulty of incommensurability be kept in the background. I would, however, while adhering to Euclid as the only possible text-book, omit, on a first reading at least, many of the propositions in order to push on to those which connect with, and can be illustrated by, practical work. For instance, after Book I., I would have read those propositions of Book III., some dozen or so in number, proving the angle properties of circles.

Seeing that demonstrative geometry furnishes by far the most accessible example of pure deductive logic, and for most boys the only one they will ever come in contact with, I would insist most strongly on its never being sacrificed to so-called "proofs" by measurement which are found in some books. The training of the reasoning powers is one of the highest aims of education, and with this end in view constant practice in riders is of the greatest value; the teaching of Euclid's text without this is a most deadly waste of time, and cannot be too strongly condemned.

In arithmetic I think the most important reform would be the general recognition of the fact that decimals are not adapted for exact calculation, but are preeminently valuable in approximation, which is the practically useful form.

From the first, therefore, boys should be taught to work out results correct to a few places only—generally not more than four—and all work with recurring decimals should be omitted.

Many of the puzzling questions set on such subjects as discount, stocks, &c., have very slight relation to practical life, they require much time to learn to deal with them, and should be discarded in favour of work on areas and volumes of simple figures. An equal amount of thought can be elicited, and therefore a not less amount of culture imparted, by good problems on the latter subjects, with the advantage of being more in touch with practical requirements.

In algebra I would, in the earlier stages, insist much more closely than is done at present on the accurate use of symbols as a shorthand language for expressing arithmetical operations, deferring long "sums" of multiplication, division, &c., until much work has been done on simple equations of the first degree as aids to the solution of problems. Later I would omit much of the harder manipulation with fractions and abnormal index expressions which is now taught, and in place of these devote much time to the development of the notion of one quantity as a function of another, illustrated by plotting graphs on squared paper. The theory of fractional and negative indices should be taught as leading up to logarithms to base 10, but I deprecate the too early use of these in calculation.

Arithmetical trigonometry involving functions of acute angles only, and with constant reference to four-figure tables and accurate drawings to scale, should be taught much more generally than it is now. For boys in the higher forms who are but poor mathematicians I have found it an interesting and stimulating change from the weary round of arithmetic and algebra they had trodden *ad nauseam* before. A short course of the same work should, even in the case of good boys, be preliminary to the algebraical treatment of trigonometry.

I have written only of the very lowest rungs of the mathematical ladder; those who from professorial and engineering altitudes lecture us on what we ought to teach have often no notion of the mind stratum in which the greater part of our life's labour is spent; hence their advice, and their books when they condescend to write for us, are too often hopelessly above the mark. That by cooperation of all interested some real improvements in the curriculum may enable us to get a rung or two higher all round is the earnest wish of myself and many other teachers.

J. W. MARSHALL.

Charterhouse.

The Distance of Nova Persei.

SINCE publishing, in NATURE of January 2, the suggestion that the cause of the apparent expansion of the nebula surrounding Nova Persei might be explained by the illumination of meteoric matter by the light sent out on the occasion of the outburst of the Nova, I have seen a paper published by Prof. Kapteyn in the *Astr. Nach.* (No. 3756), in which he suggests the same idea. His claim to priority in the matter is therefore clear. In my note, referred to, I give the distance of the Nova as 313 light years. In calculating this distance I made the mistake of taking the date of the outburst as February 12 instead of the 22nd. This made the distance of the Nova considerably too great.

Let D denote the distance of the Nova, and r the radius of the nebula, in *miles*; and let ρ be its radius in seconds of arc. Then we have

$$\frac{r}{D}=\frac{\rho}{206265}\ \therefore\ D=206265\times\frac{r}{\rho} \quad \ldots\ldots (1)$$

But if V is the velocity of light in miles per second, and if T be the time in *days* elapsed from the outbreak of the star to the date of the photograph, then

$$r=24\times 60\times 60\ .\ V\ .\ T \quad \ldots\ldots (2)$$

Substituting this in (1) we find

$$D=24\times 60\times 60\times V\times 206265\times\frac{T}{\rho} \quad \ldots\ldots (3)$$

Also if L be the distance travelled over by light in a year of $365\frac{1}{4}$ days, *i.e.* a light year, then

$$L=24\times 60\times 60\times V\times 365\tfrac{1}{4} \quad \ldots\ldots (4)$$

Dividing (3) by (4) we find

$$\frac{D}{L}=\frac{206265}{365\cdot 25}\ \frac{T}{\rho}$$

or

$$D=\Big[\ 2\cdot 75184\ \Big]\times\frac{T}{\rho}\times L, \quad \ldots\ldots (5)$$

the figures in brackets being the logarithm of $\frac{206265}{365\cdot 25}$.

Taking $T = 211$ days from the outburst to the date of the photograph taken on September 20 and the angular distance ρ of the point (*a*) on Ritchey's photograph as equal to 480″, the distance D is equal to 248 light years. The same point on the photograph of November 13 leads to $D = 265$. The difference between these two values of D is, I believe, as Prof. Kapteyn also points out, due to the fact that the plane of the nebula is not normal to the line of sight. Ritchey also points out that, besides the radial expansion, there has been an apparent motion of the nebula round the Nova in position angle. From an examination of the photographs, the nebula seems to be evidently a spiral, and the observed shift in position angle would be caused by the gradual illumination of these spiral wreaths by the advancing spherical wave of light.

It can be shown that, if the sun were removed to the distance of the Nova, it would only be of the 10·24 magnitude, so that, even at the present moment, the Nova is more brilliant than the sun. When the Nova was at its greatest brilliancy it was about 0·2 magnitude. It must then have been 10,380 times brighter than the sun. If we take the light of the Nova at the earth as equal to a first-magnitude star and take Zöllner's estimate of this compared to the sun as $\frac{1}{5 \times 10^{10}}$, then the outer margin of the nebula with a radius of 8′ would be 430 times nearer the Nova than the earth, and would receive per unit area 430^2 times the amount of light, or $\frac{430^2}{5 \times 10^{10}}$, which is equal to $\frac{1}{270500}$, of sunlight. This is about equal to 2·2 times the light of full moon. Of course, these figures are of very uncertain value and we must not place too much reliance on them, but if we take the above value of 2·2 times moonlight as that received by the nebula, it at first seems too faint to be visible as reflected light. We must, however, recollect that the light reflected from the nebula at its brightest points cannot have an intrinsic brilliancy of more than an eighteenth-magnitude star, whereas the Nova was of the first magnitude. Hence it is only necessary for the nebula to reflect light of an intrinsic brilliancy equal to $\frac{1}{6{,}310{,}000}$th that of the Nova to seem as bright as it actually is, even assuming that the nebula has no inherent light of its own. The above figures will evidently require some alterations when the photographs available are carefully measured. W. E. WILSON.

Daramona, co. Westmeath, Ireland.

A Luminous Centipede.

IN your issue of January 9 (p. 223), an account of some observations of the Geophilus is given, from which it would appear that it used its power of emitting light as a means of protection. It might be well to point out that irritation or excitation of many luminous organisms has this result. Even in such low forms as the light-producing bacteria the same effect can be seen. In a paper on the "Physical Basis of Animal Phosphorescence," by S. Watasé, of the University of Chicago, published with the biological lectures delivered at Woods Holl, 1895, a very full account is given of the phenomenon as seen in the ordinary fire-fly, and the process is essentially the same in all light-producing organisms. In some the luminous product of cell metabolism is oxidised *in situ*, while in others it is thrown out in response to a stimulus as a liquid secretion.

J. E. BARNARD.

Birds Capturing Butterflies in Flight.

MR. LATTER still believes the capture of butterflies in flight by birds to be "exceptional so far as this country is concerned" (p. 273). Closer observation would assure him of the contrary, I think. Why is the case he mentions "probably to be regarded as a mistake on the part of the bird," when it is admitted that the captor "only relinquished its hold in consequence of a luckily-aimed stick"? Why assume that the thrower of the stick knew better what the house-martin ought to eat than the bird itself? In July 1900 I saw a house-sparrow in my garden attack a common brown butterfly on the wing (species unidentified). The chase lasted three minutes, by my watch, *in the air* the whole time, the butterfly doubling and turning again and again, and the sparrow after it, in a manner most remarkable for a bird without much hovering-power. Eventually both butterfly and sparrow went into a box hedge, and the sparrow came out immediately afterwards, eating the butterfly; he finished it with much apparent satisfaction on a branch of an apple-tree, and cleaned the scales off his beak on the twig. Sparrows are not, as a rule, insect-eaters, but J. H. Gurney gives, as a result of 694 dissections, under the heading "occasional food," these entries:—

"August.—Moth of *Crambus culmellus*."

"June.—Large brown cabbage-moth (W. Johns),"

and adds: "I have notes of sparrows occasionally feeding on the yellow Underwing, Ermine moth, and a few other insects in the perfect state. . . . Everybody must, at some time or another, have observed their clumsy efforts to catch some common butterfly" ("The House-sparrow," Gurney, Russell and Coues, pp. 11–18). These notes have the greater value because they occur in a book written with the avowed object of convicting the sparrows of a diet injurious to the agriculturist!

If, therefore, attacks by "occasional" enemies are not infrequent, why imply that the toll taken by the vast crowd of insectivorous birds "*must be* very slight?" The question is, is it? Only specially directed observations can answer this.

LILIAN J. VELEY.

20 Bradmore Road, Oxford, January 26.

Extremes of Climate in the British Empire.

I HAVE just read the note on p. 87 of your issue of November 28 last giving an abstract of the "Summary of the Climate of the British Empire" in *Symons' Meteorological Magazine*; and I think that even though it is expressly said to be only "so far as it can be represented by reports for eighteen stations," such a summary is misleading. Thus, Adelaide is given as having the highest shade temperature, absolutely ignoring the fact that Lahore, with a population 50 per cent. more than Adelaide, has a maximum shade temperature for a month or more at a time rarely falling below 116°, and often well over 120°; while in Jacobabad, a much less important place, it is true, but still a garrison town, the maximum shade temperature in June and July is more often over 120° than under it.

Again, for maximum rainfall, not to mention Cherra Punji, with an average of more than 400 inches, or many places on the west coast of India and Burmah with averages of 100 to 200 inches, the large town of Rangoon is far wetter than Calcutta. Being far from records here I can only give averages; but I do not think I am wrong when I say that the places mentioned in your paragraph are hardly typical of the extremes of climate exhibited by even the *larger* places in the British Empire, which, I take it, should be the object of such a summary.

Lalitpur, India, January 2. CHAS. A. SILBERRAD.

A GALLERY OF ANIMAL ENGRAVINGS OF THE STONE AGE.

THE clever etchings on bone and ivory of the cave-dwellers of western Europe who lived towards the close of the Palæolithic period are well known to all who interest themselves in the pre-history of man. In 1895 M. E. Rivière published the first discovery of engravings and pictographs on the sides of a cavern. The second and quite recent similar record is published in the *Comptes rendus* of the Paris Academy of Sciences (December 9, 1901, p. 1038) by MM. Capitan and Breuil. These archæologists had the good fortune to discover on the walls of the cave of Combarelles, in the neighbourhood of Eyzies (Dordogne), 109 engraved figures which date from the Magdalenian epoch. All the figures are engraved upon the vertical walls of the cave for a distance of 100 metres on each side of the passage. They reach to an average height of 1·50 metres, commencing at about 15 or 20 centimetres above the ground and often extending to the roof—which, in truth, is mostly low, being only one to two metres in height, but this has been curtailed by stalagmites.

The figures are mostly deeply graven in the rock, but some designs are merely scratched. Very often they have been coated by a layer of stalagmite which is

sufficiently thick in some places to more or less completely obliterate the figures. In some figures the incisions have been reinforced by black pigment, which occasionally replaces the cuts. Sometimes, more especially about the head of certain animals, the surface of the rock is scraped away around the contour of the figure so as to throw it into a slight relief.

The style of the engravings is in complete accord with those etchings on bone and antler which occur in the Magdalenian stations, and their character proves that

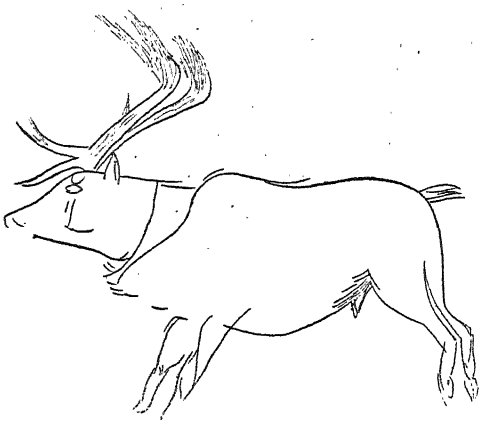

FIG. 1.—Running Reindeer, Cave of Combarelles.

they were drawn by artists who were perfectly familiar with the living animals. As in the earlier finds, the animals may be represented separately, or intermingled, or in definite groups.

Among the forty representatives of horse-like animals, at least two distinct types are recognisable. One has a massive head with a convex nose, the mane is short and stiff or long and flowing, and the tail is similar to that of our own horses. Some of these horses were domesticated; several very clearly show a halter and others a cord round the

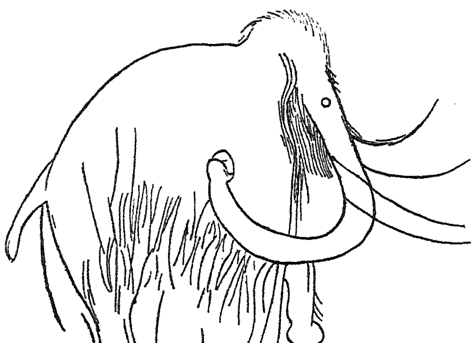

FIG. 2.—Mammoth, Cave of Combarelles.

muzzle; a covering of some sort appears to be thrown over the back of two of the horses. This new evidence, in addition to the several representations of haltered horses from the cave of Mas d'Azil, seems to prove beyond question that the horse was domesticated at this early period. Certain Equidæ are represented of a more elegant shape, with a small head, slender legs, short and always erect mane, and with a tail that arises low down and is bare save for a terminal tuft of long hair.

The representations of the Bovidæ are less frequent. Three appear to represent bisons; one is not unlike the domestic cattle of to-day; a third, with erect mane, slightly incurved horns and a dewlap provided with long and abundant hair, recalls certain African antelopes. Two heads may be attributed to the saiga antelope, and one large head suggests that of an eland, but it is without horns. There are only two entire figures of reindeer; the one which is represented as running is here reproduced. The artists have clearly indicated the differences between the reindeer and the wild deer of Europe, of which there are three examples.

The drawings of the mammoth are of interest second only to that of the horses. Of the fourteen examples, some are represented as entirely covered with hair and look like fluffy balls; others have less hair, but are provided with a fleece on the under side of the body, on the head and occasionally around the mouth, as shown in our illustration. The trunk, the tusks, which are always strongly recurved, and the great characteristic feet are very distinctly drawn; only in two figures are indicated the details of the form of the ears.

The only approach to a representation of a human face is a kind of irregular circle with an indication of two eyes and some marks for the nose and mouth. Among other simple signs were three roof-like fairly complicated designs, a double-contoured lozenge in the middle of the body of a horse, several M-like marks, semicircles, &c., which may be related to the script-like paintings found in the Mas d'Azil cave, and, finally, a group of very distinct small cups.

As only a preliminary paper has been published by the French savants, we are unable to give any further particulars of this most interesting and important find. The publication of all the particulars will be eagerly awaited by archæologists, as doubtless fresh light will be thrown upon these very remarkable troglodyte artists, who

"Pictured the mountainous mammoth, hairy, abhorrent, alone—
Out of the love that he bore them, scribing them clearly on bone."

A. C. H.

THE UNIVERSITY OF LONDON.

THE Drapers' Company has come forward with a generous offer in order to secure the incorporation of University College with the University of London. The offer is contained in the following resolution, which was brought before the Senate of the University on January 22:—"That the Drapers' Company, believing that it is for the good of the higher education in London that University College should be incorporated in the University of London, and that for this purpose it is desirable to place the site, land, buildings and endowments of the college at the complete disposal of the University, are willing to facilitate this object by making themselves responsible for the debt on University College to the extent of 30,000*l*., provided that the Senate of the University and the corporation of University College can, before February 28, 1903, agree upon a scheme for the incorporation of the college in the University, and such scheme be approved by the company."

At first sight it seems difficult to imagine how such an incorporation can be effected. Committees appointed by the University and University College will consider the matter, and it is to be hoped that the bearings of the proposal will soon be published. An additional inducement for the realisation of this scheme lies in the announcement made by Sir Michael Foster that a gentleman is prepared to give to University College 1000*l*. a year, redeemable either by himself or his executors by payment

of 30,000*l*. free (in the latter case) of legacy duty, on condition that the college becomes incorporated in the University on terms similar to those on which the gift of the Drapers' Company has been made, and satisfactory to Sir Michael Foster and two other persons to be named hereafter.

The Senate of the University has decided to devote the grant of 10,000*l*. by the London Technical Education Board to the following objects, subject to the approval of the Board and to the result of negotiations with the various institutions interested :—

(1) To found two professorships and two assistantships in chemistry ; (2) to organise the teaching of German in London by appointing two professors and three readers. The classes will be held at the colleges and polytechnics, but the fees will be paid into a central fund, and the whole staff will be under the direction of the University ; (3) to make grants of 1425*l*. and 1000*l*. a year respectively to two institutions in aid of the faculty of engineering ; (4) to appoint and pay the regular staff of teachers in the London School of Economics ; (5) to reserve 800*l*. a year pending negotiations with the London County Council as to the establishment of a day training college.

A scheme for establishing advanced courses of study on physiology in the University buildings has been approved by the Senate, and 400*l*. has been voted to meet the donation of 2000*l*. by Mr. Walter Palmer.

From the *British Medical Journal* we learn that each course will consist of not less than eight lectures, or will extend over at least eight weeks, and attendance will be open without fee to students of the University and to other persons approved by the principal. It is recognised to be essential to the success of such lectures that they should immediately proceed from laboratory work, and be in a large measure demonstrative of current research. It is, therefore, necessary that the University lecture-room should be supplied by preparations and work-rooms in which current research will be actually prosecuted. It is hoped that from the outset the University lecturers and other physiologists may be able to prosecute research in these accessory rooms, and it is strongly felt that official recognition and provision for research is in several ways essential to success, first, as a corrective of a purely verbal and didactic type of lecture, and secondly, as being calculated to stimulate the intellectual interest of University lecturers and other students. Further, the working of the scheme will afford at a relatively small cost evidence on the point whether a larger scheme for the establishment of a central institute of physiology and experimental psychology will be practicable in the future.

It is proposed that the list of annual courses of lectures shall be prepared and advertised during the preceding year, and candidates for the honours school in physiology will be permitted to nominate any two subjects on the published list for the special practical examination. The provisional arrangements are as follows :—

The first course, to begin in May, will be given by Dr. Leonard Hill, F.R.S., on the circulation. Dr. A. D. Waller, F.R.S., will give a double course, on (*a*) signs of life, (*b*) animal electricity. Prof. E. H. Starling, F.R.S., will begin a course, on the sources of animal energies, in October, and Dr. M. S. Pembrey a double course on (*a*) heat, (*b*) respiration.

The arrangements for 1903 are provisionally as follows :—January, Prof. W. D. Halliburton, F.R.S., on proteids, and Prof. W. M. MacDougall, on sense organs ; May, Dr. G. A. Buckmaster, on the blood ; and Prof. J. Bretland Farmer, F.R.S., on vegetable cytology ; in October, Dr. F. W. Mott, F.R.S., on the central nervous system, and Prof. W. R. Dunstan, F.R.S., on a subject not yet announced.

NOTES.

THE determination of the fundamental unit of electrical resistance by the late Principal Viriamu Jones ranks among the most important of such determinations, and justly acquired for him a foremost position among physicists. This determination was carried out by means of a modification of the Lorenz method, and a machine for the purpose, on which he spent 400*l*., was erected by Principal Jones at the University College at Cardiff. He was, however, of opinion that improvement was possible, and accordingly the Drapers' Company, in 1898, in recognition of his signal services both to science and to education, voted to him the sum of 700*l*. for the construction of more perfect apparatus. This apparatus he proposed ultimately to set up at the National Physical Laboratory, where preparation had been made to receive it. His illness and death prevented the realisation of these hopes, but the Drapers' Company have, with great generosity, and with a view of showing their appreciation of his merits, confirmed their vote and announced their intention of putting the sum of 700*l*. at the disposal of the committee of the Laboratory for the complete equipment of a Lorenz apparatus as a memorial to Principal Jones. The apparatus is to be erected under the supervision of Prof. Ayrton, F.R.S., and the director. This valuable gift has been accepted by the committee of the Laboratory; a tablet will be affixed to the apparatus stating that it was presented by the Drapers' Company in memory of Principal Viriamu Jones and in recognition of his great scientific attainments.

THE annual meeting of the Institution of Naval Architects will be held on Wednesday, March 19, and the two following days. The Earl of Glasgow, president, will occupy the chair. On behalf of the members of the Institution, the council has accepted an invitation to take part in the summer meeting of the Schiffbau Technische Gesellschaft, which is to be held in Düsseldorf on June 2. There will be no regular summer meeting of the Institution this year.

WE much regret to see the announcement of the death of Mr. A. W. Bennett, lecturer on botany at St. Thomas's Hospital, and the author of a number of books and papers on botanical subjects. Mr. Bennett was for several years the sub-editor of NATURE, and was an occasional contributor to these columns up to the time of his death, on January 23. He was sixty-eight years of age.

A MEMORIAL tablet is about to be placed in Harpenden Parish Church bearing the following inscription :—"In affectionate memory of Sir John Bennet Lawes, Bart., F.R.S., born at Rothamsted, December 28, 1814, died at Rothamsted, August 31, 1900. He used his long life and his great knowledge and experience as an agricultural chemist, and as a practical and scientific farmer, in the pursuit of truth, and for the benefit of his fellow men in his own country and in all parts of the world. This tablet is erected by the parishioners of Harpenden and others who deeply feel his loss as an example and friend."

THE Wellington correspondent of the *Times* states that at a public dinner given to the officers and men of the *Discovery* by the Philosophical Institute of Canterbury and the citizens of Christchurch, a number of interesting speeches were made. Captain Scott, who was loudly cheered, replying to the toast of "The *Discovery* Antarctic Expedition," said it was their intention to pass down the 175th meridian a little to the eastward of New Zealand. Then they hoped to pass down the east coast of Victoria Land, leaving records of what they had done. These records could be picked up by any relief expedition that might follow them. Next they would go to the south of

Victoria Land through those regions which Sir Thomas Ross discovered in 1840, and which they hoped to explore. They also hoped to pass along the ice barrier that stretched for 300 or 400 miles to the eastward. Then they would pass into the region of the unknown. When they returned to New Zealand, probably in two years' time, they might come back as beggars, for, though they had provisions and outfit for a three-years' cruise, wages and other things had been arranged for two years only.

THE following official statement of the plans of the Carnegie Institution (see p 278) is given in *Science*:—"It is proposed to found in the city of Washington, in the spirit of Washington, an institution which, with the cooperation of institutions now or hereafter established, there or elsewhere, shall, in the broadest and most liberal manner, encourage investigation, research and discovery, encourage the application of knowledge to the improvement of mankind; provide such buildings, laboratories, books and apparatus as may be needed, and afford instruction of an advanced character to students whenever and wherever found, inside or outside of schools, properly qualified to profit thereby. Among its aims are these: (1) To increase the efficiency of the universities and other institutions of learning throughout the country, by utilising and adding to their existing facilities, and by aiding teachers in the various institutions for experimental and other work, in these institutions as far as may be advisable. (2) To discover the exceptiona man in every department of study, whenever and wherever found, and enable him by financial aid to make the work for which he seems specially designed, his life work. (3) To promote original research, paying great attention thereto, as being one of the chief purposes of this institution. (4) To increase facilities for higher education. (5) To enable such students as may find Washington the best point for their special studies to avail themselves of such advantages as may be open to them in the museums, libraries, laboratories, observatory, meteorological, piscicultural and forestry schools and kindred institutions of the several departments of the Government. (6) To ensure the prompt publication and distribution of the results of scientific investigation, a field considered to be highly important. These and kindred objects may be attained by providing the necessary apparatus, by employing able teachers from various institutions in Washington and elsewhere, and by enabling men fitted for special work to devote themselves to it, through salaried fellowships or scholarships, or through salaries, with or without pensions in old age, or through aid in other forms to such men as continue their special work at seats of learning throughout the world."

ALL the international balloon ascents which took place in Europe on the morning of December 5, 1901, were made in an extensive area of high barometric pressure, the centre of which lay over Germany. Two recording balloons were sent up from Trappes (near Paris); one reached 14,380 m., lowest temperature $-72^{\circ}\cdot9$ C. (on ground -1°); the other reached 14,900 m., lowest temperature $-75^{\circ}\cdot8$ (on ground -3°). The Strassburg balloon rose to 6580 m., minimum temperature $-30^{\circ}\cdot5$ (on ground -2°). From Berlin two recording balloons were sent up; at 7634 m. $-38^{\circ}\cdot7$ was registered (on ground $-5^{\circ}\cdot4$); at 9606 m. $-52^{\circ}\cdot8$ was recorded (on ground -4°). Two manned balloons also ascended. From Vienna -40° was recorded at 6920 m. (on ground 1°). A manned balloon was also sent up. From Pavlovsk (near St. Petersburg) the greatest height attained was 3120 m., minimum temperature $-14^{\circ}\cdot7$ (on ground -11°). Mr. Rotch also sent up kites from Blue Hill Observatory in the afternoon. Temperatures of $-9^{\circ}\cdot9$ at 1343 m. and -9° at 800 m. were recorded. The kites remained up for two hours.

THE current number of the *Nineteenth Century* contains an instructive article on "The Reduction of Town Fogs," by the Hon. Rollo Russell. The author, who has for many years made a special study of the subject, divides fogs, so far as London is concerned, into four classes:—(1) Damp fog or mist with much cloud, from the ground up to about 1000 feet. Dust particles not numerous, and town clearer than country. (2) Damp fog or mist, dense in country. This type may be slight in London, especially if the fall of temperature has not been great. In mid-winter the fog tends to increase during the day-time in town, while in the country it rapidly dissolves. (3) Dense dry fog, with low temperature following a very cold night. It is anticyclonic in character, and the lowest strata of air are much colder than the strata at 500 to 1000 feet. Fogs of this kind are the most serious and most frequent in London; their approach can usually be foretold. (4) Occasionally a fog occurs after a severe frost, when a warm southerly wind displaces the cold air near the surface. This fog is most dangerous to traffic, being the densest. It is the least damaging to health, and may not reach more than 50 feet above the ground. The author considers that the need of the day is not so much scientific inquiry as administrative regulation, by which dark fogs might be reduced to almost harmless proportions. The preparation of forecasts is useful, as in the case of storms. Observations of the upper clouds are especially valuable in the prediction of fogs, but in London these clouds cannot always be seen; in such cases valuable data could be obtained by sending up a small balloon, with recording thermometer and hygrometer.

THE Meteorological Office pilot chart of the North Atlantic and Mediterranean for the month of February shows that very little ice was reported in the neighbourhood of Newfoundland during December, the latest date being the 11th, when a berg was seen not far from Cape Race. The Belle Isle route being closed for the winter, there were no reports from that region. Northward of Iceland unusually heavy ice has been seen. With regard to the paths of cyclonic disturbances, it is pointed out that on the eastern side of the Atlantic storm centres may be fallen in with, not only near the Azores, but even southward of the latitude of the Canaries. These, however, are much more erratic in their movements than those of the more northern ones, so that at times the changes of wind and barometer seem to be subject to no rule. On the western side of the ocean there are areas where the gale frequency this month is from 25 to nearly 40 per cent. of the wind records, the February storms being amongst the most violent and disastrous experienced in the course of the year, the exceptionally severe weather of February, 1899, being referred to as an illustration. This is the period of least fog about the banks of Newfoundland, the area of slightly more than 10 per cent. frequency being limited to a narrow strip across the southern extremity. The "smokes" of the Bight of Benin are mentioned, and it is stated as an unusual occurrence that a very dense fog visited Abaco Island, Bahamas, in February, 1901, dwellings being invisible at a distance of 100 feet. The remarks on currents deal with Rennel's Bay of Biscay current and the variations in the velocity of the Gulf Stream according to the time of day and of the lunar month, the daily maximum variation of strength being nearly 2 knots an hour and the mean daily variation about $1\frac{1}{2}$ knots. In heavy gales on the coast of North Carolina strong local currents are set up which completely mask the tidal streams. Two inset charts illustrate the easterly and northerly types of weather over western Europe at this season, and the paths of Mediterranean disturbances are dealt with.

SOME years ago Prof. J. W. Moll made experiments on the effect of forcing water into cut stems; this was managed by tying the shoot into the short arm of a U tube, containing water, and

pouring mercury into the long arm. The method is still used for demonstration purposes, but it has certain disadvantages. One of these—namely, the fact that the pressure diminishes as the water passes into the plant—the author now proposes to remove by the use of the apparatus described in a paper on the hydrosimeter (Amsterdam Academy of Sciences, vol. iv., November 1901). The arrangement by which this is effected is simple and practical, and may no doubt be useful in other cases where it is desired to subject a plant to prolonged and constant pressure. The paper is illustrated by a drawing of the apparatus, and has the merit of being written in English.

LIGHT electric motor carriages, or "runabouts" as the Americans have termed this type of vehicle, were a feature of the recent exhibition of automobiles held in New York. According to the *Electrical World and Engineer*, the Electrical Vehicle Co. of New York was represented by a light car of this type weighing only 394 kg. and provided with a battery of the new Exide cell, capable of driving the carriage 64 km. at a speed of 22 km. per hour. The American Bicycle Co. exhibited an electrical carriage weighing 450 kg. The battery in this case was composed of thirty cells, and was of sufficient power to drive the vehicle for four hours at the rate of 27 km. per hour. The Baker Motor Vehicle Co. showed a light "Stanhope" weighing 405 kg., provided with a battery of ten Planté cells, capable of driving the carriage 64 km. on one charge. The battery weighed 140 kg. It would have been interesting to know the average life of the plates in these batteries under normal road and running conditions, but upon this crucial point nothing is said in the report before us. In large towns, where several generating stations exist, and where the recharging of exhausted batteries is a comparatively simple affair, we believe there is a useful future before this type of motor-vehicle.

PROF. P. ZEEMAN, in a paper recently read before the Amsterdam Academy of Sciences, (November 30, 1901), stated that he had been investigating the limits of resolving power attainable by means of the Michelson Echelon grating spectroscope, with an instrument consisting of thirty plates, each 7·8 mm. thick, set at steps of 1 mm. Testing by means of light sources in magnetic fields of gradually increasing intensities, he found that the resolving power was almost equal to its theoretical value.

IN a paper on the energy of the universe in the *Revue scientifique*, M. I. Skvortzow discusses the influence of electrical phenomena in cosmogony. He considers that in the past history of the earth, and of other celestial bodies, electrical and chemical energy have originally played the most important part, and that heat energy has become more and more important in proportion as the earth has assumed a more material form, so that the more its energy has passed from the dynamic to the static form the greater has been the absorption of dynamical energy in overcoming resistances. The heat of the earth M. Skvortzow attributes to electric currents circulating mostly near the surface; the interior of the earth, on the other hand, he thinks may be as cold as the greatest depths of the ocean. Changes in the aspect of the earth, as well as meteorological phenomena, are attributed to electric currents induced by solar influence. The temperatures of different planets are considered to depend less on their distance from the sun than on their reserve of energy and on the currents which the sun induces in them in virtue of their axial and orbital motions. Will this theory of the electromagnetic origin of the earth's heat reconcile the two opposing views on the age of the earth?

THE somewhat heated controversy which ensued at the beginning of last year on the occasion of the starting of the London United Tramway's electrical system has borne after-fruit in the paper on earth currents derived from distributing systems which was read last Thursday before the Institution of Electrical Engineers by Mr. E. B. Wedmore. The author treated the subject of the magnetic disturbance caused by the currents leaking from the rails of a rail-return tramway system from a mathematical and practical point of view, and also discussed briefly the electrolytic troubles that may arise. To judge by the paper itself and the discussion, which was of a very quiet nature, the whole subject is in need of further investigation. This applies, perhaps, more particularly to the question of the electrolysis of gas and water pipes. With most of the speakers it seemed to be an article of faith that the leakage currents under Board of Trade rules will not do any damage worth considering, but experimental evidence, which is doubtless very difficult to procure, is wanting. There still remains to be explained the presence of the fifteen amperes which were found flowing in the London United Tramways' rails before the system had started electrical working, and it is not to be wondered at if facts such as these make gas and water engineers feel uncomfortable. Another point brought out by two speakers is worthy of notice; the term earth currents has for long definitely meant the cosmic phenomena, and should not be applied to the leakage currents from tramways, or else confusion is sure to result.

THE Dumoulin process for the electro-deposition of copper in the form of tubes does not appear to have been very successful at Widnes, where a works for operation of this process was built in 1896–1897. According to the fifth annual report of the Electrical Copper Co., it has been decided to close the works permanently and to sell the plant, since at no period of its operation has a profit been earned. This failure to earn profits is ascribed, to the small output—only thirty tons per month, to the high price of fuel, and to the heavy interest charged on the loans raised by the company. The directors in their last report, however, still speak confidently of the value of their patents (which stand in their balance-sheet at 405,000*l.*), and negotiations are to be opened for the sale of these to refiners able to work the process on a larger scale of operations. We may remind our readers that the Dumoulin process depends upon the electro-deposition of copper upon revolving mandrils; specially treated strips of skin being used to supply the friction necessary for obtaining smooth and dense deposits. The process differs from the well-known Elmore process chiefly in this substitution of skin for agate burnishers; and it is noteworthy that in neither case has the financial success realised the early expectations of the promoters of the companies operating these processes.

A REPORT on the Rampur coal-field, which lies in the Central Provinces of India, north-west of Sambalpur, has been prepared by Mr. G. F. Reader (*Mem.* Geol. Survey, India, vol. xxxii. part ii.). A good steam coal, 7 feet 10 inches thick, and two other seams of workable coal, have been proved to exist. Their extension has, however, to be determined.

WE have received from Mr. A. Gibb Maitland, Government Geologist, the annual progress report for 1900 of the Geological Survey of Western Australia. A detailed geological map of Kalgoorlie has been prepared and will be published together with a full report on the geology of this important mining centre. The lodes are for the most part bands of basic rocks, which are characterised by strong foliation, by the alteration of amphibole into chlorite and carbonates of iron, lime, manganese and magnesia, and, finally, by the development of secondary silica, mica, pyrites, gold, tellurides of gold, &c. There are no grounds for believing that the mines of Kalgoorlie have reached the limit of ore deposition, or that the lodes will not prove productive in depth. Reports on other

metal-mining districts have been made; attention has been given to the possible extension of artesian water-bearing strata, and also to borings in search of coal near Albany, where in all cases the floor of older crystalline rocks was reached without evidence of coal-bearing strata.

FROM the Iowa Geological Survey, which is under the direction of Dr. Samuel Calvin, State Geologist, we have received the eleventh volume, comprising the annual report and accompanying papers for 1900. The papers are brief memoirs on seven counties, in which the geology is described, typical sections are noted in detail, fossils are recorded, particulars are given of economic deposits and soils, and the papers are admirably illustrated. The Survey is carried on with evident vigour and ability. Special reports on coal, artesian wells, lead and zinc ores have already appeared. Dr. S. W. Beyer, one of the special assistants, has now in preparation a monograph on Iowa clays, and others are working at the materials suitable for the manufacture of Portland cement. We are informed by Dr. Calvin that the demand for the publications of the Survey has, so far as the earlier volumes are concerned, exceeded the supply. Yet much ignorance prevails, and samples of yellow mica or iron pyrites are received almost weekly from persons who imagine they have discovered gold in Iowa; and an important part of the survey work is to prevent useless explorations for geological products.

THE *American Naturalist* commences the year well, some of the articles in the January number being of more than usual interest. Among them is one by Dr. R. W. Shufeldt, on the habits of kangaroo-rats in captivity, illustrated by a couple of excellent photographs of these curious little American rodents, taken by the author from life. The specimens, three in number, which Dr. Shufeldt had under observation belonged to the species known as *Perodipus richardsoni*, and became quite tame after a few days in confinement. "They hopped about," he writes, "with great agility on their hind pair of kangaroo-like legs, while the little short pair of anterior limbs were curled inwards on the chest. . . . They are able climbers, and the rapidity with which they can dig a burrow in ordinary ground is astonishing. They use the fore-feet to perform the digging part and the long and strong hind-legs to kick the loosened soil out of their way behind, as it accumulates every moment or so. In soft soil one of these little mammals can put itself out of sight in less than a minute by digging." It is added that kangaroo-rats are in the habit of turning their cheek-pouches inside out in order to clean them. In another article in the same journal, on the best method of mounting fishes for museum-exhibition, Mr. S. E. Meek pronounces in favour of quadrangular glass-vessels, in which the specimens, after being painted on the side to be shown with water-colours, are placed in alcohol as if swimming. It is added, however, that this method, although the best yet devised, is by no means perfect, and discussion is invited from experts in the hope that a more satisfactory way of exhibiting these animals may be devised.

A POPULAR account of the principles and performances of telegraphy without intervening wires is given by Mr. S. R. Bottone in his little book on "Wireless Telegraphy and Hertzian Waves," the second edition of which has been published by Messrs. Whittaker and Co. The first edition was noticed in NATURE of September 27, 1900 (vol. lxii. p. 522).

IN the letter on the influence of temperature on the action of nitric acid on metals, which appeared in NATURE of December 12, 1901, the words "the temperature abruptly rising from 80° C. to as much as 104° C." were printed as received from Dr. A. J. Ewart, who, however, now informs us that they should read "the temperature abruptly rising *to* from 80° C. to as much as 104° C."

A SECOND edition, revised and extended, of Dr. S. Rideal's work on "Water and its Purification" has been published by Messrs. Crosby Lockwood and Son. The original edition was reviewed in these pages on April 29, 1897 (vol. lv. p. 602), and the book remains substantially the same, though changes have been made in the chapter on the characters of natural waters, and there are several additions dealing with recent water epidemics and with sand filtration. It is a little surprising to find in a scientific book that the employment of a dowser or "water-finder" is suggested, and the cautious remark is made with reference to water-finding that "if further research should discover a physical law underlying the process, its utility would become more certain and extended." The same remark could just as reasonably be made of astrology, chiromancy, or any other process of divination.

A CATALOGUE of protected rheostats, measuring instruments and electrical apparatus relating to them has been issued by Messrs. Isenthal and Co. The rheostats have been devised to economise space on switchboards and elsewhere and to minimise the chances of short circuit. In the Electra Rheostats (Schindler-Jenny's patents) the resistance wires are embedded in a highly refractory, insulating material, and a protecting sheet of metal is cast around the latter. Instruments constructed upon this plan do not possess the defects commonly found in other embedded rheostats, and they are particularly suitable as motor-starting rheostats for continuous and rotary current. The Dimmer switches, also included in Messrs. Isenthal's list, provide a means of moderating the light of electric incandescent lamps. By means of a reducing rheostat in the switch the light of an electric lamp connected with it may be given four degrees of brightness, from the dimness of a night light to full luminosity. The measuring instruments include several types of voltmeters, ampèremeters, and cell testers, for workshop and laboratory use.

THE twenty-third communication from the laboratory of van 't Hoff to the Prussian Academy of Sciences, on the conditions of formation of the oceanic salt deposits, contains a summary of the results obtained from the investigation of solutions saturated at 25° C. with sodium chloride and containing the chlorides and sulphates of magnesium and potassium. As the result of this series of researches, the conditions of existence of a large number of the Stassfurt salts in contact with aqueous solutions, and inversely the conditions necessary for the separation of these salts from the mother liquors, have been accurately established. The salts or minerals for which these valuable data have been obtained are—bischofite, sylvine, thenardite, carnallite, glaserite, astrakanite, reichardtite, kieserite, schönite, leonite and kainite, all of which may separate from solutions at 25° C. The two salts langbeinite and löweite are apparently not capable of existence in contact with solutions at this temperature, and their occurrence in the Stassfurt layers points to the prevalence of a higher temperature than 25° C. in the formation of these natural deposits.

THE additions to the Zoological Society's Gardens during the past week include a Rhesus Monkey (*Macacus rhesus*) from India, presented by Mr. C. Hunterbrocken; a Patas Monkey (*Cercopithecus patas*) from West Africa, presented by Mr. A. Richmond; two Sharpe's Wood Owl (*Syrnium nuchale*), a White-throated Monitor (*Varanus albigularis*) from West Africa, presented by Mr. William Cross; a Bengalese cat (*Felis bengalensis*) from the East Indies, two Egyptian Geese (*Chenalopex aegyptiacus*) from Africa, an Anaconda (*Eunectes murinus*) from South America, a Black Sternothere (*Sternothaerus niger*) from West Africa, deposited; a Barasingha Deer (*Cervus duvaucelli*) from the Himalayas, received in exchange.

OUR ASTRONOMICAL COLUMN.

ASTRONOMICAL OCCURRENCES IN FEBRUARY.

Feb. 1. 19h. 10m. to 20h. 29m. Moon occults β^2 Scorpii (mag. 5·2).
1. 19h. 10m. to 20h. 28m. Moon occults β^1 Scorpii (mag. 3·0).
3. 0h. Mercury at greatest elongation (18° 17′ E.).
6. 17h. Jupiter in conjunction with moon. Jupiter 5° 26′ S.
8. 17h. Venus in conjunction with moon. Venus 3° 9′ N.
9. 9h. Mercury in conjunction with moon. Mercury 2° 23′ S.
12. 7h. 40m. to 8h. 18m. Moon occults ϵ Piscium (mag. 4·5).
14. 5h. 53m. to 6h. 45m. Moon occults σ Arietis (mag. 5·5).
14. 11h. Venus in inferior conjunction with the sun.
16. 6h. 24m. to 7h. 18m. Moon occults i Tauri (mag. 5·1).
17. 11h. 41m. Minimum of Algol (β Persei).
20. 8h. 30m. Minimum of Algol (β Persei).

VARIABILITY OF THE SATELLITES OF SATURN.—In the *Bulletin de la Société Astronomique de France* (January 1902), M. L. Rudaux directs attention to the probable variation in the brightness of the satellites Titan and Japetus, from evidence furnished by observations since 1892. He concludes that in the case of Titan the change is about half a magnitude, from 8·0 to 8·5, and, moreover, the variation appears to occur regularly at the same parts of the satellite's orbit. Maxima occur near and just after west elongation, and minima when the satellite is between superior conjunction and east elongation. A suggested explanation supposes the existence of fixed regions of different brightness and the rotation period equal to the time of revolution, as in the case of our own moon. There is a rapid passage from maximum to minimum.

The satellite Japetus is also thought to have equal periods for rotation and revolution, and the observation of Cassini is confirmed that the body almost becomes invisible in the eastern portion of its orbit. The variation is from the ninth to twelfth magnitude.

Prof. T. J. J. See refers to the variable visibility of Japetus in an article giving measures of the diameters of the satellites of Jupiter and Saturn in *Astronomische Nachrichten* (Bd. 157, No. 3764). He says, "The disc of Titan is rather obscure, but that of Japetus is even more so; in fact, only one side gives sufficient light to enable the observer to recognise a disc. This is visible when the satellite precedes the planet."

MAGNETIC OBSERVATIONS DURING TOTAL SOLAR ECLIPSE, MAY 18, 1901.—In a pamphlet reprinted from the *Overgedrukt uit het Natuurkundig Tijdschrift voor Ned-Indië* (vol. lxi., part iii. pp. 173–193), Dr. W. van Bemmelen presents the observations undertaken at Batavia and Karang Sago (Sumatra) during the last total eclipse of the sun on May 18, 1901. The determinations were made on behalf of the Batavia Observatory in response to the appeal of Dr. L. A. Bauer for accurate measures. The observations were made both visually and by means of self-recording photographic apparatus, reproductions from these latter being given. Although complicated by the presence of various common disturbances, the curves show decided irregularities about the time of eclipse which are thought to be due to the occurrence of that phenomenon. The observations at Batavia were only rendered possible by the courtesy of the Electric Car Company in stopping traffic over their lines from 11.30 a.m. to 2.30 p.m. on the day of eclipse.

SIMULTANEOUS VISIBILITY OF SUN AND TOTAL LUNAR ECLIPSE.—In the *Transactions* of the Vienna Academy of Sciences (Section of Mathematics and Natural Sciences) No. xxiv. pp. 263–271, Herr Dr. C. Hillebrand directs attention to the possible observation of both sun and total lunar eclipse at such times when the phenomenon occurs as the moon is rising or setting. As the refraction at the horizon is greater than the diameter of the lunar or solar disc, the sun will be visible after true sunset or before true sunrise; the conditions for the eclipsed moon to be thus seen may be fulfilled at certain localities during the lunar eclipses of April 22 and October 16 of the present year.

THE VALIDITY OF THE IONISATION THEORY.[1]

Introduction.—The theory of electrolytic dissociation as advanced by Arrhenius in 1887 is based primarily upon the facts that the molecular conductivity of solutions increases with the dilution, that substances which, when dissolved, conduct electricity also have abnormally low molecular weights in such solutions when tested by osmotic or freezing- or boiling-point methods, and that the so-called degree of dissociation may be calculated from the electrical conductivity or the results of the molecular weight determinations. In his original article, Arrhenius states that the phenomena of electrolysis, when viewed from the standpoint of thermodynamics, require the assumption of free ions, as was pointed out by Clausius, and that the well-known additive properties of solutions support this hypothesis. Arrhenius sought to save van 't Hoff's theory of solutions from having but a limited application, and to extend it.

Van 't Hoff found it necessary to introduce the factor i in the case of electrolytic aqueous solutions in order to make them conform to the gas equation. This factor Arrhenius calculated from the electrical conductivity on the one hand and from molecular weight determinations on the other, the resulting figures showing an agreement to within 5 to 15 per cent. The agreement was not good, and the results were obtained exclusively from aqueous solutions. The non-aqueous solutions then known were practically non-conductors, and appeared to be fairly normal as regards van 't Hoff's theory, so that non-aqueous solutions in general came to be regarded as having normal molecular weights and as being non-conductors.

Behaviour of Non-aqueous Electrolytic Solutions.—Previous work has already shown that non-aqueous electrolytic solutions are frequently abnormal in the light of the ionisation theory. Thus in many cases the molecular conductivity decreases with increased dilution, *e.g.* NaI and NaBr in benzonitrile, $AgNO_3$ in piperidine, $FeCl_3$ in pyridine and in benzaldehyde, and CoI_2 in $POCl_3$. In other cases the molecular conductivity at first increases and then decreases with dilution, *e.g.* $FeCl_3$ in paraldehyde, CBr_3COOH in $POCl_3$. Many solutions which, according to molecular weight determinations, are undissociated, conduct well. Thus $AgNO_3$ has a normal molecular weight in pyridine and benzonitrile, yet it conducts fairly well. According to Dutoit and Friderich, CdI_2, LiCl, NaI, $HgCl_2$ and NH_4CNS have normal molecular weights in acetone, and yet these solutions are conductors. Walden has found that KI, NaI, RbI, NH_4I and KCNS conduct well in liquid SO_2, and yet have abnormally large molecular weights in this solvent. Franklin and Kraus have found that while NH_4NO_3, $NaNO_3$ and KI dissolved in liquid ammonia are excellent conductors, the boiling points of the solutions are not nearly so high as they ought to be according to the ionisation theory. Nicolo Castoro found by means of the freezing-point method that $AgNO_3$, $CdCl_2$, $HgCl_2$ and $ZnCl_2$ have normal molecular weights in urethane; yet the author has found that the first three of these solutions are conductors. Recently, Innes found the molecular weights of succinic, salicylic and tartaric acids to be normal in pyridine according to the boiling-point method; preliminary tests by the author have shown that all three of these solutions are fairly good conductors.

In the case of non-aqueous solutions the various methods of observing ionisation do not always give the same indication with increasing dilution; it is sometimes in one direction and sometimes in the other. Occasionally simple substances in solution show abnormally low molecular weights, and yet are non-conductors. The author has found this to be so in the case of solutions of diphenylamine in methyl cyanide.

The abnormal behaviour, according to the theory, of non-aqueous solutions led the author to investigate aqueous solutions somewhat further.

Experimental Part.—The investigation consisted of four parts:—(1) Determination of boiling points of aqueous solutions of typical, common, chemical compounds from low to very high concentrations, to see how the molecular weight changes with the concentration. (2) Measurement of the conductivity of these solutions at or near their boiling points. These two parts of the work were carried out by Mr. A. A. Koch. (3) Measurement

[1] Abstract of a paper by Mr. Louis Kahlenberg in the *Journal of Physical Chemistry* (vol. v. pp. 339–392, June, 1901).

of conductivity at 0°. These determinations were made by Mr. R. D. Hall. (4) Cryoscopic determination of the molecular weights. The results of (1) and (2), and also of (3) and (4), were comparable, being under similar conditions.

The conductivity determinations were made by means of the usual Kohlrausch method with a telephone. The measurements at 0° were made in baths of melting ice. Those near the boiling point were not carried out at the boiling point, but at 95°, as small gas bubbles were apt to form at the electrodes at 100°. The freezing-point determinations were made with a regular Beckmann's apparatus of large size, about 40 grammes of water being used in each case. The solutions were cooled only from two to three tenths of a degree below their freezing points, and the crystallisation was inaugurated by means of a point of ice. The boiling-point determinations were made with a Beckmann's apparatus of about double the ordinary size, and thermometers graduated to 0°·01. It was at first thought best to surround the thermometer with a platinum cylinder in the boiling tube, as recommended by Jones, but fluctuations in the boiling point were found to result, apparently due to the solution within the cylinder being more concentrated than that without.

The water used was distilled in a block-tin condenser and had its conductivity reduced to 2×10^{-6} by drawing air through it free from carbon dioxide. In the results given, the conductivity of the water at the proper temperature has been deducted. Water of crystallisation was determined and allowed for in making up solutions, these being based on the amount of anhydrous salt present.

Conductivity measurements at 0° and at 95° are given for NaCl, KCl, KBr, KI, $MgCl_2$, $BaCl_2$, $HgCl_2$, $KClO_3$, KNO_3, $AgNO_3$, $MgSO_4$, $ZnSO_4$, $MnSO_4$, $CdSO_4$, $NiSO_4$, $CoSO_4$, $FeSO_4$ and $CuSO_4$. The volume in litres containing a gramme equivalent was varied from ¼ to 8192 in the case of the determinations at 0°, and from ½ to 2048 in the case of those at 95°. The results show an increase of the equivalent conductivity with dilution and the same trend in the curves at the two temperatures, but they are not parallel. For example, the curve between equivalent conductivity and the cube root of the volume is nearly a straight line for $MgSO_4$ at 95°, but much more curved at 0°. Curves of salts belonging to any one group all have the same trend.

The freezing-point determinations include NaCl, $MgSO_4$, $ZnSO_4$, $MnSO_4$, $CdSO_4$, $NiSO_4$, $CoSO_4$, $FeSO_4$ and $CuSO_4$. The results are summarised below :—

Sodium Chloride.—For about 0·2 normal solution the molecular weight was found to be 32·6, equivalent to 79·4 per cent. ionisation; for an approximately normal solution (the strongest used) the molecular weight was 31·7, equivalent to 84 per cent. ionisation. According to the conductivity tests the ionisation is about 79 per cent. for a 0·2 normal solution and 70 per cent. for the normal solution. The results are, therefore, about the same by both methods for the dilute solution, but whereas the ionisation increases rapidly with dilution according to the conductivity, it remains constant or diminishes according to the cryoscopic method. This result is confirmed by the work of C. Dieterici and of R. W. Wood.

Magnesium Sulphate.—The limits were about 0·1 and 1·5 normal. The degree of ionisation for the first was 40 per cent. and for the second only 5 per cent. According to the conductivity measurements the ionisation should be 44 and 22 per cent. respectively, showing an increasing discrepancy with concentration.

Zinc Sulphate shows no ionisation in a normal solution, yet the conductivity is nearly the same as that of $MgSO_4$, and indicates 24 per cent. ionisation. The molecular weight in the strong solutions was above the normal.

Manganous Sulphate shows at first an increase of molecular weight with concentration and then a decrease. The same is true of $ZnSO_4$ and $CdSO_4$, and to a slight extent of $NiSO_4$, $CoSO_4$ and $CuSO_4$. According to the conductivity of these solutions, the ionisation increases constantly with the dilution, but according to the cryoscopic measurements there is first a decrease and then an increase with increasing concentration. An approximately N/4 solution of $MnSO_4$ gave a molecular weight of 125·2, or 21 per cent. ionisation, the conductivity method giving 35 per cent. In a solution giving a molecular weight of 146·5 the ionisation is 3 per cent., whereas conductivity indicates 20 per cent.

Cadmium Sulphate, though a good conductor, shows no ionisation except in the most dilute solution (3·071 gm. $CdSO_4$ in 100 gm. of water), which gave 12 per cent. ionisation, the conductivity indicating 30 per cent.

Nickel Sulphate appears to be un-ionised when the strength is 10 per cent., but the conductivity shows 22 per cent. ionisation. In the most dilute solution the two methods gave about the same result.

Cobalt Sulphate.—The freezing point shows no ionisation when the solution is 5 per cent. or stronger, whereas the conductivity indicates 26 per cent. when the observed molecular weight is 155·2. In the most dilute solution the molecular weight was 131·8, corresponding to 18 per cent. ionisation, the conductivity indicating 34 per cent.

Ferrous Sulphate also is un-ionised in 6 per cent. solutions or above, according to cryoscopic determinations, yet the conductivity indicates 24 per cent. ionisation when the observed molecular weight is 154·8 (*i.e.* above the normal), and ionisation should be absent. The most dilute solution showed a molecular weight of 135·8, or 12 per cent. ionisation, the conductivity indicating 30 per cent.

Copper Sulphate is like the last two salts. When the observed molecular weight is 163·9, corresponding to no ionisation, the conductivity indicates about 22 per cent. In the most dilute solutions tested the molecular weight corresponds to 38 per cent. ionisation and the conductivity to 32 per cent.

The results obtained with copper sulphate are as follows, similar results for the other salts being given in the original paper :—

Copper Sulphate (*$CuSO_4$*). *Molecular Weight*, 159·7.

Amount of $CuSO_4$ in 100 gm. water.	Lowering of freezing point.	Molecular Weight.
1·835	0·300	115·6
3·312	0·405	154·6
6·443	0·743	163·9
9·242	0·996	175·4
14·210	1·569	171·2

The agreement, therefore, of the methods, viz. conductivity and freezing points, is poor, even in the dilute solutions. Arrhenius originally gave figures from cryoscopic measurements indicating no ionisation for $MgSO_4$, $FeSO_4$, $CuSO_4$, $ZnSO_4$, $CdSO_4$ and CdI_2, whereas ionisation was indicated by conductivity. He sought to explain this, in the case of the sulphates, by polymerisation of the un-ionised molecules, basing this assumption on the fact that Hittorf found the migration numbers of $MgSO_4$ and $ZnSO_4$ to show a considerable variation with concentration. This was also true of CdI_2, for which Hittorf consequently assumed double molecules, and applied the same explanation to other salts of the magnesia series. This at first seems to justify the position taken up by Arrhenius. However, the latter has not applied the explanation to all salts of the magnesia series, but has assumed polymerisation simply for those salts that did not behave according to his theory. $MgCl_2$ is a case in point. Similarly, Hittorf found the migration numbers of $CaCl_2$, $BaCl_2$, $Ca(NO_3)_2$ and $Ba(NO_3)_2$ strongly dependent on concentration, but Arrhenius did not assume polymerisation, for these salts agree better with his theory. To assume polymerisation in the case of $MgCl_2$, $CaCl_2$ and $BaCl_2$ would render it difficult to explain the results of Jones and Chambers, who found a minimum for the molecular lowering between 0·1 and 0·2 normal, and that the lowering in concentrated solutions was as great as, or greater than, that corresponding to complete ionisation. These authors attempt to explain this by assuming that the salts form hydrates. Thus another theory is brought in to account for abnormally low freezing points, to explain which the ionisation theory was itself originally introduced. Results of a similar kind have been observed by C. Dieterici.

The boiling-point determinations given by the author refer to NaCl, KCl, KBr, KI, $MgCl_2$, $BaCl_2$, $HgCl_2$, $KClO_3$, KNO_3, $AgNO_3$, $MgSO_4$, $ZnSO_4$, $MnSO_4$, $CdSO_4$, $NiSO_4$, $CoSO_4$, $FeSO_4$ and $CuSO_4$.

In the case of NaCl, KCl, KBr and KI the molecular weights continually diminish with increase of concentration, finally becoming less than half the theoretical values, whereas the molecular conductivity increases regularly with the dilution.

The molecular weight of $MgCl_2$ and of $BaCl_2$ decreases with increasing concentration until it becomes less than one-third the theoretical value, but the conductivity in both cases increases with the dilution.

$HgCl_2$ shows no ionisation by the boiling-point method. The molecular weight increases with concentration. It might be assumed that polymerisation takes place and, further, that some of the molecules which are not yet polymerised are ionised and thus account for the conductivity, which, though low, increases with the dilution.

In the case of $KClO_3$, KNO_3 and $AgNO_3$ the molecular weight increases with concentration, and there is good agreement with the conductivity measurements. Thus $AgNO_3$ in the most dilute solution tested appeared to be ionised to the extent of 65 per cent., while the conductivity method showed 67 per cent. For a normal solution the boiling-point method indicated 54 per cent. and the conductivity 52 per cent. The agreement is closer at the boiling point than at the freezing point.

In the case of $MgSO_4$ the molecular weight begins, in the dilute solution (2·733 gm. in 100 gm. of water), with a value above the theoretical, indicating no ionisation; then it increases with the concentration, and finally decreases after passing through a maximum, the values in the concentrated solutions becoming less than the theoretical. But there is no irregularity in the conductivity values. What has been said of $MgSO_4$ applies also to $ZnSO_4$, $NiSO_4$ and $CuSO_4$. The same general behaviour is also exhibited by $MnSO_4$, $CdSO_4$, $CoSO_4$ and $FeSO_4$, except that the molecular weights of these salts, while first increasing and then decreasing with increase of concentration, always remain above the theoretical values. The molecular weight of the sulphates is less by the freezing-point results than by the boiling-point method. So that if it be assumed that the molecules are polymerised, this polymerisation is greater at the higher temperature.

A series of boiling-point determinations was made on a solution of cane sugar, as an example of a non-electrolyte. It was found that the molecular weight diminished appreciably as the concentration increased, becoming less than the normal (212 in a solution of 289·4 gm. in 100 gm. of water, as compared with the normal 342). But, as is well known, the solution does not conduct. A test with Fehling's solution showed that no invert sugar had been formed by the boiling. Solutions of H_3BO_3, on the other hand, show practically constant molecular weight with varying concentration.

Discussion of Results.—From the above results it appears that there are solutions which are excellent conductors and which, nevertheless, show a normal molecular weight of the solute. While in some cases the molecular weight increases with the concentration, thus agreeing qualitatively at least with the ionisation theory, in other cases the molecular weight decreases with increase of concentration, finally becoming less than what it ought to be even for complete ionisation. In other cases the molecular weight at first increases with concentration and then diminishes. But the conductivity of these solutions continually increases with dilution. There are cases, however, in which the conductivity at first increases with the dilution and then decreases, *e.g.* aqueous solutions of the alkaline hydroxides.

It follows, therefore, that there is no such connection between freezing points and boiling points of solutions on the one hand and their conductivity on the other as is claimed by the ionisation theory. Often there is not even a qualitative agreement. Want of agreement is to be found in the original table of Arrhenius, but this was ascribed to experimental errors.

Various properties of electrolytes have been explained by the ionisation theory. Thus the various additive properties of salt solutions are presented as supporting the theory. But the theory cannot be based on additive properties of this kind, for such are known to exist in the case of true chemical compounds, where, since there are no solutions under consideration and since there is no electric conductivity observable, the possibility of ionisation is out of the question. In the realm of physiology, also, the theory cannot cope with the facts.

The heats of neutralisation of acids and bases have been used as an argument in favour of ionisation; Crompton, however, has shown that the theory is not only unnecessary, but that it is inadequate. Again, the theory cannot be brought into harmony with the law of mass action, which is one of the strongest arguments against it.

The chemical reactiveness of electrolytes has been explained by attempting to ascribe to the ions a peculiarly strong chemical activity on account of the electrical charges that are supposed to reside upon them. In this connection attention is drawn to the action of water in frequently facilitating chemical action. While this fact may be in agreement with the ionisation theory, it cannot be used to support it; for there are many pure substances and mixtures that are very active, although there is no ground for assuming the presence of ions; *e.g.* many explosives. It is well recognised that many bodies unite with the solvent, and interaction then takes place between the new products, reactions taking place which might easily not occur between the original anhydrous bodies.

It has been supposed by Nernst and by J. J. Thomson that the higher the dielectric constant of a solvent the greater its ionising power. But many exceptions are now known, *e.g.* liquid NH_3, butyronitrile and pyridine (H. Schlundt), liquid SO_2 (Walden), liquid HCN, and amylamine.

That the ionising power of solvents is dependent upon the polymerisation of their molecules, as claimed by Dutoit and Aston, has been shown to be incorrect in many cases by Kahlenberg and Lincoln.

The ionisation theory is at its best in explaining electrolysis, but there are many phenomena which the theory does not explain. For example, why are the deposits of silver from some solutions poorly adherent and from others dense and well adhering, the potential difference and current density being the same?

As to the ionisation theory being required by thermodynamics, Clausius, who showed the discrepancy in the Grotthus theory, did not find it necessary to put forth such a radical hypothesis as that of Arrhenius. Nor did Hittorf find it necessary to frame such a theory. Finally, no marked improvements or discoveries in electrolysis are due to the theory. It has led to Nernst's theory of the E.M.F. of galvanic cells and a formula which really involves the assumption that the law of mass action is applicable to electrolytes in the sense required by the ionisation theory. That this law does not hold has already been mentioned. By maintaining the correctness of this formula and thus assuming that the law of mass action holds for electrolytes, Jahn has arrived at the conclusion (as clearly he must) that the ratio of the equivalent conductivity at a given concentration to that at infinite dilution does not correctly represent the degree of ionisation, and that the ionic velocities vary in dilute solutions. This has given rise to a discussion in the *Zeits. Phys. Chem.*

If the ionisation theory is not true, then the original difficulty with the van 't Hoff theory of solutions recurs, viz. the theoretical interpretation of the factor i in the gas equation. Of course this equation is supposed to hold strictly only for ideal gases. A normal solution, however, is rather dilute for many of the practical purposes of life. Not that one expects the gas equation to hold strictly for a normal solution, but what one has a right to expect from the modern theory of solutions is that, with increasing concentration, a solution should behave at least qualitatively as a gas does with increase of pressure. The ionisation theory does not satisfactorily explain the significance of the factor i. In any case this factor should never be placed equal to unity without experimental evidence, whether in connection with electrolytes or non-electrolytes.

Substances of similar chemical composition, when dissolved in the same solvents, behave similarly so far as boiling points or freezing points are concerned; this shows that the influence of the chemical nature of the solute affects these variations.

The analogy between gases and solutions has been pressed too far, so that it has been forgotten that we are dealing only with an analogy. The solution of a substance and the expansion of a gas are really very different. A gas will expand in vacuo or mix with any other gas, but a substance will not dissolve in every liquid. And here lies the difficulty of the theory. It neglects the all-important *rôle* of the solvent. It fails to emphasise the fact that the process of solution takes place because of a mutual attraction between solute and solvent, and this attraction is the essence of the so-called osmotic pressure, which is closely related to, if not essentially identical with, chemical affinity. The attraction between solvent and solute should be recognised. Each solution should be examined separately, beginning with the most concentrated, the behaviour of the most dilute solutions appearing as a limiting case; then we shall see the present theory of solutions in its true relation to the facts.

W. R. C.

AN ITALIAN ELECTRIC RAILWAY.

THE motive power on our great railways forms such an important question that any enterprise made with a new motive power, electricity or otherwise, adapted so as to utilise the existing rolling-stock, not only may at some future time greatly accelerate the present speed, but also introduce great economies, especially if the new power can be derived from a natural source. In Italy the railway authorities have been thoroughly alive to this fact; a portion of the railway of northern Italy has been electrically equipped for running by means of electric motors, as a pioneer installation, and if successful the remainder will be similarly equipped. The Valtellina electric railway (says *Feilden's Magazine* for January), which is sixty-two miles long, runs from Lecco along the shores of Lake Como to Colico, where it divides, one branch going to Sondrio and the other to Chiavenna. The power of the line is furnished by falling water from the river Edda, which operates four turbines (2000 h.p. each) and which, coupled direct with four Schubert three-phase generators, give a current at 20,000 volts and 15 cycles. This current is led to ten substations (placed about six miles apart) along the route, where it is transformed to 3000 volts, at which voltage the various sections of the line are fed. The two overhead trolley wires which supply the motors (the railway track forming the third) are hung from steel wires supported on each side by posts spread with crossbeams; these also carry the main supply wires (20,000 volts). The traffic of the line comprises both goods and passenger, and it is worthy of note that for the former electric locomotives are used for the haulage of the wagons (which are of the standard Italian type), and for the passenger traffic bogie motor-cars act in place of locomotives and pull four coaches as trailers (these latter also of the ordinary Italian type). A train of this description is run at thirty-nine miles per hour on all gradients less than 10 per cent.; for anything steeper than this "the Cascade" arrangement of motors is used, then the speed is halved. The speed of the goods traffic is twenty miles per hour with a load of 250 tons. The line is equipped with every facility for safe working, everything being made as automatic as possible. For instance, "when a train receives a block signal it also has its current cut off so that it cannot proceed." Again, "where a train is coming up at full speed, and it is necessary to order it to stop owing to sudden occurrence of something in front, the signalman not only makes the signal to stop, but he also cuts off the current and applies the full brake power available to the advancing train." Lightning has been fully guarded against. The power house is supplied with a group of conductors of the "Horn" type outside the building, and lightning arresters of a similar type are fitted in the substations, and, lastly, the electric locomotives and motor-cars have also similar apparatus fitted. The working of the line will not only be watched with interest, but also forms an important example of electric traction on account of its newness in design (especially in detail), and the thorough way in which the system is made automatic and interlocking and also safely guarded against accidents.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

CAMBRIDGE.—Mr. W. E. Johnson, of King's College, has been appointed the first Sidgwick lecturer in moral science.

The Balfour studentship in animal morphology will be vacant at Lady Day next. Applicants are requested to send their names, with such information as to their qualifications and proposed researches as they may think desirable, to Mr. J. W. Clark, Scroope House, Cambridge, by February 28.

The complete degree of M.A. *honoris causa* is to be conferred on Dr. W. E. Dixon, London, assistant to the Downing professor of medicine.

THE proposal to establish a University of Liverpool was warmly supported at a meeting held at the Liverpool Town Hall on Monday, the Lord Mayor of the city being in the chair. At the close of the meeting it was announced that the sum of 80,000*l.* has been promised in support of the scheme.

THE Lord Lieutenant of Berks (Mr. J. Herbert Benyon) has been elected president of Reading College, in succession to the late Lord Wantage. A fund of 1000*l.* a year for five years has been raised to augment the existing income. Lady Wantage, Mr. Benyon and Mr. Alfred Palmer have each contributed 250*l.* a year to this fund.

IT is proposed to erect a bronze tablet in the museum at Marischal College, Aberdeen University, in honour of the late Prof. H. Alleyne Nicholson. Prof. J. Arthur Thomson and Mr. J. E. Marr, F.R.S., have undertaken the preliminary steps and are prepared to receive subscriptions from "those who were friends, colleagues, collaborateurs or old students" of Prof. Nicholson.

MR. T. J. I'A BROMWICH, Fellow of St. John's College, Cambridge, has just been appointed professor of mathematics in Queen's College, Galway, in succession to Prof. A. C. Dixon, lately appointed professor of mathematics in Queen's College, Belfast. Mr. Bromwich graduated as senior wrangler in 1895, and subsequently obtained a first class (first division) in the second part of the mathematical tripos. Since taking his degree he has made a number of original contributions to various branches of mathematics.

ANNOUNCEMENT is made in the *Times* that Lord Curzon, the Viceroy of India, has appointed a commission to visit the University centres and colleges of India to inquire into their prospects, report on their working, and recommend measures for the improvement of the teaching and the standard of learning. The commission is composed as follows:—Mr. T. Raleigh, president; Syad Hossain Bilgrami Nawab; Mr. J. P. Hewett, Secretary to the Home Department; Mr. A. Pedler, Director of Public Instruction in Bengal; Prof. A. Bourne, Principal of Madras College; and the Rev. Mr. Mackichan, Principal of Wilson College, Bombay. Mr. R. Nathan will act as secretary.

PROTESTS are being made against the dissolution of Victoria University. It is suggested that there might be one great University for the north and not several connected with single cities. At a meeting of graduates of Victoria University held at Leeds on January 24, a resolution was unanimously adopted expressing the conviction that to abolish the Victoria University would be detrimental to the interests of higher education in the north of England. A committee was appointed to attend an approaching meeting at Manchester in connection with the Victoria University and protest against its disruption. The board of governors of the Yorkshire College, Leeds, has adopted a resolution expressing the view that though the dissolution of the Victoria University in favour of separate universities would be detrimental to the interests of education in the north of England, still, having regard to the resolutions passed by Owens College, Manchester, and University College, Liverpool, preparations should be made for the establishment of a University for Yorkshire based upon the existing Yorkshire College, with provision for the admission of other constituent colleges and for the affiliation of other suitable institutions.

THE annual meeting of the Association of Directors and Organising Secretaries for Technical Education was held on Friday last. Mr. A. Keen, the president, delivered an address dealing with the question of rural education. He urged that what are wanted are:—(1) A system of suitable elementary instruction which should include practical work in every standard; (2) a good supply of secondary schools at low fees of the rural grammar school or modern school type, taking, say, the Rural School of Science course in the Government Directory, and such other studies as the circumstances of different districts might direct; (3) a more limited supply of higher secondary schools of the high-grade grammar school type for boys and girls who were intended to continue their education beyond the usual age, and probably go to a university or some other place of advanced education; and (4) for the benefit of boys intended to be farm bailiffs, agents, stewards, farmers, or market gardeners, and especially those who had no suitable means of acquiring at home an intimate knowledge of farm and garden work and general practical experience, there should be in every large county, and in every group of smaller ones, a farm school, or an agricultural school or college, for boys of fifteen to sixteen years of age and upwards, providing a course of instruction for two or three years of a thoroughly practical character.

AN interesting introductory address delivered by Prof. Wilson, professor in anatomy at Sydney University, has been sent to us. The address is entitled "Ideals in Medical Education"; it is

well worthy of careful perusal, and in a short paragraph only the very salient points can be touched upon. The author begins with a plea for centralisation and a note of warning against the multiplication of universities, when ample means are not to hand for their equipment. Local convenience is undoubtedly an important consideration, as is also emulation between districts for the possession of intellectual centres, but both of these should be subordinate to the true interests of education. The equipment of the modern university is necessarily a very costly matter. The next point we can consider is the length of the medical curriculum. Prof. Wilson directs attention to the value of general education to the medical student, and views with regret the abolition by many universities of the obligatory preliminary degree in "Arts." In this connection he refers to the new regulations at Harvard, in which it has been enacted that the medical student shall undergo a preliminary four years' course in arts before entering upon his four years' medical curriculum. In view of the present controversy concerning elementary medical education, it is of interest to note that the author appears to accept the general educational value of special medical studies, but is apparently not in favour of the relegation of physics, chemistry and biology to the schools. The chief reason against this is the assumption that it would still add another year to the curriculum, and "this might be as well done frankly under university guidance." It may be objected, however, that the boy could perfectly well begin these studies at sixteen, and it is certainly a very open question whether at such an age he is better at the school or university. With regard to pharmacology, Prof. Wilson would relegate the experimental part entirely to the physiologist and the therapeutical part entirely to the physician. He apparently does not see in pharmacology as at present taught what he describes so accurately in the case of general pathology, namely, a "bridge-like" position in the medical curriculum, fitting the student, when essentially pursuing the intermediary subjects, for the problems awaiting him in the wards, and enabling him to utilise to the full the relatively small clinical experience which he will obtain. In conclusion, Prof. Wilson admits that the medical curriculum is at present full to overflowing, and recommends a somewhat novel plan to relieve it. He suggests, and instances certain American universities as precedents, a more universal use of the honours system. He would establish a system of "elective studies," would allow the student to specialise earlier in his career, and while demanding certain evidence of all-round knowledge, would very considerably reduce the standard in it, according to the depth and thoroughness of the work done by the student in certain directions. It must be admitted, however, that the magnitude of the irreducible minimum would be difficult to decide, as would also the thoroughness of "work done by the student in certain directions."

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, May 23, 1901.—"On the Intimate Structure of Crystals. Part v.—Cubic Crystals with Octahedral Cleavage." By Prof. W. J. Sollas, F.R.S.

November 21, 1901.—"On Skin Currents, Part ii. Observations on Cats." By Augustus D. Waller, M.D., F.R.S.

In part i. it was stated that the normal electrical response of frog's skin to excitation is outgoing, from internal to external surface. In the skin of the pad of the cat's foot the electrical effect of excitation of the sciatic nerve proved to be ingoing, as stated by Luchsinger and Hermann. Dr. Waller determined this fact by decapitating cats and immediately testing the effect of excitation of the sciatic nerve on the pad of the foot; the effect gradually declines and disappears an hour after decapitation. It is pointed out that this experiment on a freshly killed animal is a convenient class demonstration of a fundamental fact which it has hitherto been thought necessary to demonstrate on living animals. The effect is elicited after the sciatic has ceased to provoke muscular contraction; the largest response observed and photographed was ·0100 volt, the lost time was three seconds.

In order to observe the response to direct excitation, the pad of a cat's foot was cut off and set up between unpolarisable electrodes; during the first forty-eight hours there is a normal ingoing current of ·0100 volt. If after exact compensation of this current a single induction current is sent in in either direction, the after-effect is nearly always outgoing, as in frog's skin; an ingoing effect is observed with a fresh skin and weak excitation.

Dr. Waller thinks it probable that both ingoing and outgoing forces may co-exist in the excited skin, the galvanometer expressing the resultant. In order to investigate the causes of the variability of the direction of response, the A B C method is devised:—Three electrodes are applied to the external surface of the skin, the third electrode C being used to examine separately the effects at A and B. By means of an especially designed switch called the M-shaped switch, an excitation can be applied at A and B, and the response led off through C and A, or C and B. The response is found to be always an outgoing current at A or B for both directions of excitation.

Physical Society, January 24.—Prof. S. P. Thompson, president, in the chair.—A paper on the factors of heat was read by Mr. James Swinburne. In all branches of physics, except heat, energy is divided into pairs of factors. Heat is generally thought of as a sort of indivisible energy and is not split into factors, but is treated as a whole, so that we have conductivity for heat, capacity for heat, specific heat, &c. Capacity for heat and specific heat are also taken when they include external work, at constant pressure for instance; so that the capacity is reckoned as capacity for energy which is only partly in the body or substance. So little is heat realised as energy that it has its own unit, so that equations involving other forms of energy with it need to be complicated with a coefficient. Temperature might be a factor of heat, but there is no corresponding quantity factor. There is no unit of temperature, it is measured in degrees which have no proper connection with anything. Temperature is sometimes treated as a tension factor with heat as the quantity factor, as when heat is said to run down temperature. Heat is thus regarded as its own quantity factor. Entropy is sometimes incorrectly used as the quantity factor corresponding to temperature. Entropy is at present indispensable as a function involving information as to whether heat has been or might have been converted into work. The author discusses "chy" as a possible factor for use with absolute temperature where "chy" is a quantity factor such that when multiplied by the temperature at which it is added or withdrawn gives the energy added or withdrawn. In the θ, χ system capacity, specific capacity and conductivity vary inversely as the temperature. These factors are not analogous with the factors of other forms of energy and are not convenient. The energy of heat is therefore split into $\tau\,\pi$, where τ is proportional to the square root of the temperature and is called by the author "tasis." The other factor, π, is called "posot." In any gas, tasis is proportional to the effective velocity and posot to the momentum. Tasis and posot are analogous to the tension and quantity factors already in successful use and indispensable in the treatment of other forms of energy. Conductivity of posot follows Ohm's law and the capacity of a body for posot is constant.

Chemical Society, January 16.—Prof. J. Emerson Reynolds, V.P.R.S., president, in the chair.—An investigation of the radio-active emanation produced by thorium compounds, by Prof. Rutherford and Mr. Soddy. The authors have previously shown that whilst thoria gives rise to a Becquerel radiation, it also communicates to gases passed over it a radio-active substance referred to subsequently as the emanation. They find that the emanating power of the oxide is destroyed by heating and can be restored by reprecipitation, and, further, that probably the emanating power is not a specific property of thoria, but is due to the presence of some foreign substance. As regards the nature of the emanation itself, it appears to be a gas of the argon type, since it is not destroyed by such powerful agents as red-hot lead chromate, white-hot platinum black, red-hot magnesium, &c.—The constitution of hydrocyanic, cyanic and cyanuric acids, by Dr. F. D. Chattaway and Mr. Wadmore. It is generally assumed by chemists at the present time that in these substances the hydrogen is joined to carbon and that they must be represented by such formulæ as H.C⋮N, HO.C⋮N, &c. The view that they are really the *iso*-compounds of the formulæ C:N.H, O:C:N.H, &c., is again brought forward by the authors, and the evidence afforded by the behaviour of the haloid cyanogen compounds—which is that of substances containing the haloid joined to nitrogen—is shown to necessitate their representation by such *imino*-formulæ.—A modification of Zeisel's method for the estimation of methoxyl groups, by Dr. J. T. Hewitt and Mr. T. S. Moore. The

complicated apparatus designed by Zeisel is greatly simplified by the substitution of a fractionating column consisting of nine aludels, alternately closed and open, arranged in series in a glass tube, for the sloping condenser with water at 40° C. and the washing bulbs containing amorphoric phosphorus. Results obtained with codeine and quinine proved that this rearrangement is effective in retaining iodine and hydriodic acid.—A new colour reaction of hydroxylamine, by Mr. W. C. Ball. When a solution of hydroxylamine or its salts is boiled with a solution of ammonium-sulphite until sulphur begins to form and to the liquid a strong solution of ammonia is added, together with a few c.c. of alcohol, a fine purple colour is produced which is visible when only one part of hydroxylamine in 500,000 of water is used.—On the sensitiveness of a thermoregulator, by Mr. A. W. C. Menzies. A description of an apparatus whereby a definite temperature may be maintained over considerable periods with a maximum variation of ·0025 of a degree.—Myricetin, Part ii., by Mr. A. G. Perkin. An account is given of the methyl and ethyl ethers of this colouring matter, extracted from the bark of the Indian tree *Myrica nagi*, and which has already been shown by the author to be a hydroxyquercetin. Myricetin appears not to occur free in the plant, but in the form of a rhamnose ether (glucoside), which has been named *myricetrin* ($C_{21}H_{22}O_{13}$).—The colouring matters of green ebony, by Messrs. A. G. Perkin and S. H. C. Briggs. This dyewood contains (*a*) *excoecarin*, $C_{13}H_{12}O_5$, easily oxidised by bromine to *excoecarone*, $C_{13}H_{10}O_5$, and hydrolysed by potash fusion to hydroquinone carboxylic acid. (*b*) Jacarandin, $C_{14}H_{10}O_3(OH)_2$, which appears from its reactions to belong to the quercetin series of dyes.—The action of methylene iodide on aryl- and naphthylamines; diaryl methylene diamines, acridines and naphthacridines, by Dr. Senier and Mr. Goodwin. With anilines, toluidines and xylidines, diamines are formed, but with amine of condensed substances such as naphthalene, bodies of the acridine type are produced.—The polymerisation of cyanic acid, by Dr. Senier and Mr. T. Walsh. In this reaction cyamelide is not, as is generally supposed, the only product, a quantity of cyanuric acid being also formed.

Mathematical Society, January 9.—Dr. Hobson, F.R.S., president, in the chair.—The president (Major MacMahon, F.R.S., vice-president, in the chair, *pro tem.*) communicated a paper on non-uniform convergence and the integration of series. Messrs. Larmor, Love, Whittaker and the chairman spoke on the subject of the paper, which followed out the work of Prof. Osgood.—Mr. S. Roberts, F.R.S., read a paper on networks. This paper treats of certain networks (1) with triangular meshes, (2) with polygonal meshes. They are intimately connected with the problem of colouring maps with four colours only. The doubts and difficulties which have arisen with regard to the demonstration of the general theorems involving the solution of the problem in question show the expediency of discussing limited and defined cases and passing to more general results step by step. The subject, the author says, is, in fact, larger and more intricate than the simplicity of the empirical solution would lead one to expect. The late Prof. Tait's theorem is animadverted upon and is considered to have been enunciated in too general a form. In connection herewith reference is made to Prof. Petersen's communication (*cf.* "L'Intermédiaire des Mathématiciens," vol. v., p. 226). But it is not certain that Prof. Tait was responsible for the unguarded statement (*cf. Phil. Mag.*, vol. xvii. pp. 30, &c.). In any case Prof. Petersen's example shows that the theorem is not absolutely general.—The president communicated a paper by Mr. W. H. Young, on the fundamental theorem of differential equations. The fundamental theorem of the modern theory is Cauchy's existence theorem, dealing with the existence and uniqueness of a set of integrals satisfying given initial conditions and the holomorphic character of the solution. Some doubt has been expressed as to whether the proofs furnished by Picard and Painlevé are rigorous. It has been suggested that it has not been conclusively demonstrated that the holomorphic solution is unique even in the simplest case which can arise. The paper gives a brief account of the theorem in question, and examines an example which has been put forward as typical of a large class of cases where the theorem fails.—A paper by Prof. W. Snow Burnside, on the integrals of the differential equation

$$\frac{du}{\sqrt{f(u)}}+\frac{dv}{\sqrt{f(v)}}=0, \text{ where } f(x)\equiv aax^4+4bx^3+6cx^2+4dx+e,$$

considered geometrically, was communicated by title.

Geological Society, January 8.—Mr. J. J. H. Teall, V.P.R.S., president, in the chair.—A system of glacier-lakes in the Cleveland Hills, by Mr. P. F. Kendall. After referring to existing "extra-morainic" lakes, such as the Märjelen See and those of the Chaix Hills, the author proceeds to deal with the criteria for the recognition of such lakes. These include beaches, deltas, floor-deposits and overflow-channels. Shore-scarps are common in Cleveland, but beaches are rare or absent, the reason being in part that stability was rarely secured owing to the overflows being over soft Jurassic strata. Deltas also are not common. The floor-deposit of lakes may be distinguished from river-alluvia by the fact that the lamination is close and regular, but, being parallel to the subjacent surface, it may be highly inclined. On the other hand, alluvia are laid down on horizontal surfaces, but rarely show good lamination. Evidence from borings and drift-filled channels is given to show that during or before the Glacial period the land was considerably above its present level. The Glacial deposits are described in detail from sections and borings, some of them carried out by the author, and the assemblages of boulders are identified and classified into three chief groups—a western group, from the Solway, Vale of Eden, Stainmoor Pass and the Tees; a northern group, from the Tweed and Cheviots and from eastern Durham; and an eastern group, from the Christiania region, the Gulf of Bothnia and Denmark or the North Sea. The author has been unable to detect any signs of the presence of the sea in this area at any time during the Glacial period. Three main ice-masses appear to have been concerned in producing the deposits—one from the southern Uplands and the Solway, joined by the local ice of the Tees; a second originating in the Tweed Valley, and driven southward round the Chevoits by the pressure of the third, or Scandinavian, ice-mass. The general order of events is supposed to have been: (1) the unobstructed passage of the Teesdale glacier to the coast, (2) the arrival of the Scandinavian ice, and (3) the invasion of the Scottish ice. The first of the extra-morainic lakes described is that of the Vale of Pickering, the lowest of the sequence, which for a long period received all the drainage of the district except that of the western margin, and the outflow from which into Lake Humber was that now occupied by the River Derwent. Newton Dale was the outflow of the lake-series of the Eskdale country. The Eskdale system comprises a series of lakes connected by an "aligned sequence" of overflows; and here it is possible to trace the consequences of the shrinkage of the ice-masses and to follow out the low-level phases of the lake. The ice pressing upon the northern face of the Cleveland Hills gave rise to a series of lakelets, connected with which are the following set of overflows:—Scugdale and Scarth Nick, Bilsdale, Kildale, Ewe Crag Beck, Tranmire, and Egton Moor. Iburndale contained a lakelet overflowing eastward. Behind a narrow coast-strip of country, extending from Robin Hood's Bay to Hunmanby, there runs a gorge which receives all the drainage of the "hinterland" and carries it into the Vale of Pickering. In the production of this arrangement the effects of an ice-sheet shutting the seaward ends of the valleys are traceable; the position of the main overflows was stable, and the drainage was permanently deflected.—The glaciation of Teesdale, Weardale and the Tyne Valley, and their tributary valleys, by A. R. Dwerryhouse. After an account of the topographical solid geology of Teesdale, the author describes four distinct types of drift in the area. A detailed description of the Glacial deposits, boulders and striæ is given, and from this the following conclusions are deduced:—Upper Teesdale was heavily glaciated by local ice from the eastern slope of the Cross Fell Range; this part of the Dale was not invaded by any other ice, and the higher peaks stood out as nunataks. At the period of maximum glaciation a number of lakes were formed, owing to the obstruction of the drainage of lateral tributary-valleys by the ice of the main glaciers. Lunedale was occupied by ice (the Stainmoor glacier) which came from the drainage-basin of the Irish Sea, joined the Teesdale glacier about Middleton-in-Teesdale, and by its thrust deflected the Teesdale ice into the valley of the Wear. During the retreat of the ice there was a lengthened period of "constant level," when well-marked drainage-channels were formed, and after this the ice was removed with great rapidity. A tongue of ice flowed from Upper Teesdale by Yad Moss to the Valley of the South Tyne.

Zoological Society, January 14.—Prof. G. B. Howes, F.R.S., vice-president, in the chair.—Dr. A. S. Woodward, F.R.S., exhibited a newly-discovered upper molar tooth of Onohippidium from the cavern near Consuelo Cove, in Last

Hope Inlet, Patagonia. This new specimen was fixed in the bone and bore trace of the soft parts.—Mr. Oldfield Thomas, F.R.S., exhibited and made remarks upon the skin of a female yellow-backed duiker (*Cephalophus sylvicultrix*) which had been obtained in the Awemba district of north-eastern Rhodesia, and presented to the British Museum by Mr. Robert Codrington. This species had previously been known only from West Africa. —Mr. Tegetmeier exhibited the skin of an animal which it had been suggested was a hybrid between a hare and a rabbit, but which proved to be merely a variety of a hare.—Prof. E. B. Poulton, F.R.S., read a paper (illustrated with lantern-slides) by Mr. R. Shelford, curator of the Sarawak Museum, on cases of mimicry amongst Bornean insects and spiders. The author, who had carefully studied this subject in the Malay Archipelago, had made some striking discoveries, and among them were: (1) the well-marked mimetic resemblance of the Mantispidæ to the Hymenoptera; (2) the wonderfully large and complex group of insects of all kinds which mimicked the common dammar bee (*Trigona apicalis*); (3) the large amount of mimicry in longicorn beetles, some resembling Hymenoptera, others Phytophaga, others Lycidæ and others Rhynchophora; (4) the fact that longicorns of the genus Chloridolum and also of some genera of Clytinæ were mimicked by other longicorns; and (5) the re-discovery of the locustid *Condylodera tricondyloides*, formerly described by Westwood from Java, being a splendid mimic of the cicindelid Tricondyla.—A communication was read from Mr. F. H. A. Marshall, describing the variation in the number and arrangement of the male genital apertures in the Norway lobster (*Nephrops norvegicus*), as observed on an examination of a series of 1080 specimens of this crustacean.—A paper was read by Dr. Einar Lönnberg chiefly dealing with the alimentary canal of Trichosurus, Pseudochirus, Phalanger and Petaurus. The varying length of the different sections of the gut and their structure were correlated with the varied food of these marsupials.—A communication from Dr. L. von Lorenz gave an account of the mounted specimen of the quagga (*Equus quagga*) in the Imperial Museum of Natural History at Vienna, and pointed out its differences from other known specimens of this animal.—Mr. J. Lewis Bonhote contributed a paper on a small collection of mammals made by Mr. Th. H. Lyle in Siam. Of the eight species enumerated in the paper, a hare was described as new under the name of *Lepus siamensis*.—A communication from Dr. A. G. Butler contained an account of two collections of Lepidoptera made by Sir H. H. Johnston, K.C.B., in the Uganda Protectorate during the year 1900. The species, of which specimens were contained in the collection, were enumerated, and three of them, viz. *Harma johnstoni*, *Pseudathyma plutonica* and *Aphnaeus hollandi*, were described as new.—Mr. W. L. Distant communicated a paper on the insects of the order Rhynchota collected by Sir H. H. Johnston, K.C.B., in the Uganda Protectorate, in which it was pointed out that the species, of which specimens were contained in the collection, showed marked affinities with the West African forms of these insects.

Entomological Society, January 15.—The sixty-ninth annual meeting, the Rev. Canon Fowler, president, in the chair. —It was announced that the following had been elected officers and council for the session 1902–1903:—President, the Rev. Canon Fowler; treasurer, Mr. Robert McLachlan, F.R.S.; secretaries, Mr. Herbert Goss and Mr. Henry Rowland-Brown; librarian, Mr. George C. Champion; and as other members of council, Mr. R. Adkin, Prof. T. H. Beare, Mr. Arthur J. Chitty, Mr. W. L. Distant, Dr. F. D. Godman, F.R.S., the Rev. Francis D. Morice, Prof. E. B. Poulton, F.R.S., Mr. Edward Saunders, Dr. David Sharp, F.R.S., and Colonel Swinhoe. The president announced that he should appoint Dr. F. DuCane Godman, F.R.S., Prof. E. B. Poulton, F.R.S., and Dr. D. Sharp, F.R.S., as vice-presidents for the session 1902–1903. He then delivered an address in which he dealt chiefly with the question of protective resemblance and mimicry in the case of the Coleoptera, a branch of the subject concerning which but little has been recorded, although mimicry in this order is quite as important as in the case of the Lepidoptera; as a matter of fact, beetles are protected in many ways: by a hard integument, by the assimilation of colour or form to environment, by adopting colours in strong contrast to environment (warning colours), by protective attitudes, by warning attitudes, by warning sounds, by the secretion of distasteful juices or odorous substances, by resemblance to unpleasant substances such as the droppings of birds, by resemblance to well-protected insects other than Coleoptera such as ants, bees and wasps, by imitating other genera and species of the same order which are plainly distasteful. In the course of the address it was pointed out how easily it can be proved that beetles form a large part of the food of birds, as their hard elytra or wing-cases remain for some time entire in their stomachs; in this way it can be proved which species are most liked, and which are disliked or rejected. It is an interesting fact that many of the rapacious birds devour large numbers of beetles, and that a systematic examination of the stomachs of birds proves that the damage done to game is much less than is usually believed, for many of the most persecuted species are mainly or to a very great extent insectivorous; it would be well, therefore, on all grounds, that the indiscriminate slaughter of our few remaining birds of prey should be rigorously discountenanced.

PARIS.

Academy of Sciences, January 20.—M. Bouquet de la Grye in the chair.—On the use of lunar distances at sea, by M. E. Guyou. The method for the determination of the longitude by lunar distances has fallen into disrepute during the last century, and the Bureau des Longitudes has decided that the amount of work required each year for the prediction of lunar distances is out of all proportion to the benefit derived from them by mariners; in the next volume of the *Connaissance des temps*, for 1905, these calculations will accordingly be discontinued. In the present paper a simplified formula is worked out for the case of those navigators who still wish to use this method.—On some properties of fused lime, by M. Henri Moissan. Quicklime, if pure and free from silicate, is melted only in small quantity and with great difficulty at the highest temperature obtainable with the oxy-hydrogen blowpipe; it is, however, melted with great ease in the electric furnace, and with an arc of 1000 amperes first melts and then boils. On cooling, the crystals were found to belong to the cubical system, although after keeping for some months the crystals broke up into others which acted upon polarised light. The density of the lime was raised from 3·3 to 3·4 by fusion. Since lime forms the basis of the electric furnace, it was of importance to study the effect of heating it to high temperatures with various substances. The results of the reactions with carbon, silicon, boron, titanium, chromium, manganese, iron, nickel, cobalt and platinum are given.—The analysis of some antique metallic objects, by M. Berthelot.—On the passage from hermaphrodism to the separation of the sexes by unilateral parasitic castration, by M. Alfred Giard. It appears probable that there exists in the Compositæ parasitic fungi of several kinds. The morphogenic action of these upon their host varies, and the influence of these parasites upon the condition of sexuality of their hosts is equally variable, and furnishes natural experiments of great interest for general biology.—On the conditions to the limits in hydrodynamics, by M. P. Duhem.—On the growth of entire functions, by M. Pierre Boutroux.—Remarks on the preceding communication, by M. Paul Painlevé.—On factorial series, by M. Niels Nielsen.—Coincidences between the elements of the planets, by M. Jean Mascart.—On the application of the Lagrangian equations to electrodynamic and electromagnetic phenomena, by M. Liènard. M. Carvallo, starting with the example of Barlow's wheel, comes to the conclusion that the equations of Lagrange are not always applicable to electrodynamic phenomena, especially in the case of conductors of two or three dimensions. In the present paper it is shown that this restriction is unnecessary and that a rigorous application of the Lagrangian equations gives perfectly exact results in the case of the motion of Barlow's wheel.—Electrodynamics of bodies in motion, by M. E. Carvallo.—Critical constants and molecular complexity of some organic compounds, by MM. Ph. A. Guye and Ed. Mallet. The conclusion is drawn that all the aliphatic nitriles are clearly polymerised, their coefficients of polymerisation being larger than have been hitherto observed.—On some physical properties of hydrogen selenide, by MM. de Forcrand and Fonzes-Diacon. The gas was obtained in a pure state by the action of a little water upon pure aluminium selenide over mercury. Its boiling point under ordiaary pressure was found to be −42° C., its melting point −64° C., and its density in the liquid state 2·12 at −42° C. Its solubility in water was found to be less than has usually been supposed.—Remarks on the oxides of molybdenum, by M. Marcel Guichard.—On the decomposition of acetylene during its combustion, by M. Fernand Gaud. An experimental study into the causes of the choking

up of acetylene burners.—On the tribromo- and triiodo dinaphthoxanthonium and on the hydrobromic, dibromo-, and hydriodic diiodo-ethers of the supposed binaphthylene glycol, by M. R. Fosse.—On the action of the mono-halogen propionic esters upon the sodium derivative of acetyl-acetone, by M. Fr. March.—Contributions to the study of the chemical modifications in plants submitted to the influence of sodium chloride, by MM. E. Charabot and A. Hébert. The addition of common salt to the soil has the following effects: it increases the percentage of organic matter in the plant, and also increases the relative loss of water. At the same time that this double influence is exerted on the plant, the sodium chloride favours esterification and reduces the transformation of menthol into menthane.—The biological theory of vision, by M. Georges Bohn. A criticism of the theory of vision put forward by M. Pizon. Of the three essential ideas of this theory, M. Bohn regards the first as not new and the two latter as not true.—The elementary forms of phosphorus in the invertebrates, by M. Jean Gautrelet. In the blood, carapace and shells of crustacea and molluscs, phosphorus exists in two elementary forms, mineral and organic.—The utilisation of sugars by the organism, by MM. Charrin and Brocard. —On the assimilation of sugar and of alcohol by *Eurotyopsis Gayoni*, by M. P. Mazé. The analytical results quoted would tend to show that the mycelium of this fungus is capable of utilising both alcohol and ammonia without loss of material.—The indications of the prophylaxy and treatment of pulmonary tuberculosis, by MM. Albert Robin and Maurice Binet.—On the origin of certain diseases of chrysanthemums, by M. Chifflot. Two diseases of the chrysanthemum described by M. Joffrin as new have been well known for some time both to botanists and horticulturists.—The siliceous tufa of Côte-aux-Buis, at Grignon, by M. Stanislas Meunier.—On the appearance of lesions in a foal analogous to those produced in its mother by an accident, by M. Le Hello.

DIARY OF SOCIETIES.

THURSDAY, JANUARY 30.

ROYAL SOCIETY, at 4.30.—The Chemical Origins of the Lines in Nova Persei: Sir Norman Lockyer, K.C.B., F.R.S.—The Specific Volumes of Oxygen and Nitrogen Vapour at the Boiling Point of Oxygen: Prof. J. Dewar, F.R.S.—The Distribution of Magnetism as affected by Induced Currents in an Iron Cylinder when rotated in a Magnetic Field: Prof. E. Wilson.

ROYAL INSTITUTION, at 3.—Recent Excavations at Delphi and in the Greek Islands: Dr. A. S. Murray.

FRIDAY, JANUARY 31.

ROYAL INSTITUTION, at 9.—The Ions of Electrolysis: Prof. A. Crum Brown, F.R.S.

INSTITUTION OF CIVIL ENGINEERS, at 8.—The Quay-Walls of Keysham Harbour: J. C. Collett and W. H. C. Clay.

INSTITUTION OF MECHANICAL ENGINEERS, at 8.—Discussion of the Paper by Mr. H. F. L. Orcutt, on Modern Workshop Methods.

MONDAY, FEBRUARY 3.

SOCIETY OF ARTS, at 8.—The Purification and Sterilisation of Water: Dr. Samuel Rideal.

IMPERIAL INSTITUTE, at 8.30.—The Native Races of Nigeria: Dr. C. F. Harford-Battersby.

SOCIETY OF CHEMICAL INDUSTRY, at 8.—The Explosion of Potassium Chlorate by Heat: Dr. A. Dupré, F.R.S.—The New Table Photometer and Standard Pentane Burner prescribed by the Gas Referees for use in the London Gas-testing Stations: Dr. F. Clowes.

TUESDAY, FEBRUARY 4.

ROYAL INSTITUTION, at 3.—The Cell: its Means of Offence and Defence: Dr. A. Macfadyen.

SOCIETY OF ARTS, at 4.30.—The History of the Rosary in all Countries: Rev. Herbert Thurstan, S.J.

ZOOLOGICAL SOCIETY, at 8.30.—Ecdysis, as Morphological Evidence of the Original Tetradactyle Feathering of the Bird's Fore-limb: Edward Degen. —A Revision of the Amblypodia-Group of the Lycænidæ: G. T. Bethune-Baker.—Notes on the Osteology of *Cogia breviceps*: Prof. W. Blaxland Benham.

INSTITUTION OF CIVIL ENGINEERS, at 8.—*Papers to be further discussed*: The Sewerage Systems of Sydney, N.S.W., and its Suburbs: J. Davis.—The Bacterial Treatment of Trades Waste: W. Naylor.

MINERALOGICAL SOCIETY, at 8.—On the Hornsilvers: G. T. Prior and L. J. Spencer.—The Identity of Kilbrickenite with Geocronite: Analyses of Miersite, Marshite and Copper-Pyrites: G. T. Prior.—A New Sapphirine-like Mineral from Ceylon: G. T Prior and A. K. Coomara-Swamy.—Attempts to reproduce Interference-Effects by Three-Colour-Printing: Prof. Miers.

WEDNESDAY, FEBRUARY 5.

SOCIETY OF ARTS, at 8.—Jamaica: Herbert T. Thomas.

GEOLOGICAL SOCIETY, at 8.—On the Matrix of the Suffolk Chalky Boulder-Clay: Rev. Edwin Hill.—On the Relation of certain Breccias to the Physical Geography of their Age: Prof. T. G. Bonney, F.R.S.—On some Gaps in the Lias: E. A. Walford.

ENTOMOLOGICAL SOCIETY, at 8.

SOCIETY OF PUBLIC ANALYSTS, at 8.

THURSDAY, FEBRUARY 6.

ROYAL SOCIETY, at 4.30.

SOCIETY OF ARTS, at 4.30.—The Coal Resources of India: Prof. W. R. Dunstan, F.R.S.

LINNEAN SOCIETY, at 8.—On a Method of Investigating the Gravitational Sensitiveness of the Root-tip: F. Darwin, F.R.S.—An Extinct Family of Ferns: Dr. D. H. Scott, F.R.S.

CHEMICAL SOCIETY, at 8.—An Investigation into the Composition of Brittle Platinum: W. N. Hartley.—Conversion of *l*-Hydroxycamphene into β-Halogen Derivatives of Camphor: M. O. Forster.—Tetrazoline, Part II.: S. Ruhemann and H. E. Stapleton.—(1) The Solubilities of the Calcium Salts of the Acids of the Acetic Acid Series; (2) The Equilibrium between a Solid and its Saturated Solution at various Temperatures: J. S. Lumsden.—The Influence of Temperature on Association in Benzene Solution, and the Value of the Molecular Rise of Boiling Point for Benzene at Different Temperatures: W. R. Innes.—The Magnetic Rotation of Ring Compounds; Camphor, Limonene, Carvene, Pinene, and some of their Derivatives: W. H. Perkin, sen., F.R.S.—Polymerisation Products from Diazoacetic Ester: O. Silberrad.

RÖNTGEN SOCIETY, at 8.30.—A System of Radiography: E. W. H. Shenton.

FRIDAY, FEBRUARY 7.

ROYAL INSTITUTION, at 9.—The New Mammal from Central Africa and other Giraffe-like Animals: Prof. E. Ray Lankester, F.R.S.

GEOLOGISTS' ASSOCIATION, at 7.30.—Annual General Meeting.—Address on a Dozen Years of London Geology (Eocene, Chalk, and Underground): W. Whitaker, F.R.S., President.

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THURSDAY, FEBRUARY 6, 1902.

RELIGION AS A SCIENTIFIC STUDY.

The Study of Religion. By Morris Jastrow, jun., Ph.D. Contemporary Science Series. Pp. xiv + 451. (London: Walter Scott, 1901.) Price 6s.

PROF. JASTROW is chiefly known on this side of the Atlantic as an exponent of the ancient religion of the Euphrates valley. The work now before us exhibits its author not merely as an Oriental scholar, but as a scholar of wide and original thought, of keen and sympathetic insight. It is a notable book in a series which has included many notable books.

Beginning with an excellent sketch of the history of the study, Prof. Jastrow proceeds to discuss the classification of religions, the various definitions proposed for religion, and, finally, the origin of religion. These form a preliminary division, which is followed by a consideration of special aspects of the study, namely, the relation of religion to ethics, philosophy, mythology, history and culture. Four chapters devoted to certain practical aspects of the study then bring the work to a conclusion.

Anthropological students will naturally turn with the greatest interest to the chapter in which the author discusses the question of origin. They will agree with much of his criticism on the various theories put forward to account for the phenomena which we class together under the name of religion. An original revelation is now everywhere discredited. Modern science and a larger and more sympathetic view of human nature equally reject the crude theories of the philosophers of the eighteenth century. When, however, Prof. Jastrow leaves these behind and reaches Dr. Tylor and Mr. Herbert Spencer, he seems to be confounding in his criticisms two distinct things—the earliest form of religion and the origin of religion. Little consideration is required to show that the earliest form and the origin are not identical conceptions. Either the animistic theory of the former thinker or the ghost-theory of the latter may correctly present the earliest form assumed by religion, and yet the origin of religion itself may remain undiscovered. In other words, there must be behind the earliest form the possibility of life, the inchoate material ready to take shape. Religion is not a simple phenomenon, as the author rightly points out; it is a complex of thought and emotion. What we want to ascertain is what are, reduced to their lowest terms, the components of this complex, and how did they come together to make the germ of that universal characteristic of mankind—religion.

To these questions Prof. Jastrow adopts the answer of Max Müller which ascribes the origin of religion to "the perception of the infinite." Now Max Müller is a very dangerous guide to follow. He knew little of savage belief and savage custom. He derided the efforts of anthropologists to account for myth and custom, whether of the Greeks or of the Hottentots. He himself built up an elaborate system based on a study of the Vedas and philological comparisons. After it had been riddled with shell and rendered completely untenable he was still dwelling in a fool's paradise, despising his antagonists because they were not Sanskrit scholars. And so he continued to the end. One of the last things he did was to publish a reply which exhibited his utter unconsciousness of many of the real problems about religion considered as a human phenomenon. In his solution of the origin of religion as "the perception of the infinite" he was acting like his fellow-countryman in the camel-story. He was evolving the idea of the origin of religion from the depths of his inner consciousness. He had not gone to the nearest representatives accessible to our inquiry of the primitive human being. He had not questioned them. He had not examined their modes of thought, their customs, their beliefs, with the hope of obtaining a clue to those of their hypothetical ancestor. He would no more have thought of doing so than Hobbes or Rousseau. Hence his answer to the question of the origin of religion is not the result of induction, it is "a shot." It is a shot by a very acute and accomplished man, and so perhaps in the right direction. It may miss its mark by excess, rather than by falling short; or by misdirection. But it misses its mark all the same.

The general course of human evolution is upward, not downward. We may therefore assume that the hypothetical ancestor with whom religion originated was a less developed being as to mental and moral characteristics than his descendant, the modern savage. Has any traveller or missionary ever found a modern savage with a perception of the infinite? Perception of the vague, the indefinite, the mysterious, the awful is common to the race; but perception of the infinite is beyond the power of any but the cultivated intellect of a philosopher, if even he can attain to it. Prof. Tiele, whom Prof. Jastrow quotes, tries to avoid the difficulty, while giving the weight of his distinguished authority to the general theory, by speaking of "man's original, unconscious, innate sense of infinity." And Prof. Jastrow himself admits that "such a concept as infinity is a self-contradiction on the part of a finite intellect." Yet he thinks this "need not deter us from according to it a strong influence over primitive man, and all the stronger because of his failure to grasp it clearly." Does the phrase, then, mean anything more from the pen of Prof. Jastrow (whatever Max Müller may have meant by it) than the sense of the mysterious, the awful? If it be simply a pompous way of saying this, it harmonises with what we know of the savage mind and is sufficient to satisfy Prof. Jastrow's own requirements when he says that in seeking for the origin of religion

"we must look for something which could stir [primitive man's] emotions deeply and permanently, which could arouse thoughts that would henceforth never desert him and would prompt him to certain expressions of his emotions and thoughts, so definite and striking as to become part and parcel of family or tribal tradition."

If it mean more than this it goes beyond those requirements and imputes to primitive man powers of thought and ideas incomparably beyond any yet discovered among savage races, while it ignores the practical considerations which must have immediately and profoundly influenced him.

I have dwelt upon this point because it is obviously cardinal in a work on the scientific study of religion.

And I regret that a writer ordinarily so clear-sighted and judicious has been misled by one whose services to the study of Hindu religion and literature can hardly be overrated, and whose contributions to philology and, indeed, the science of religion it would be the veriest ingratitude not to recognise. The rest of my task is more pleasant. To discuss a subject so vast as religion in a little volume of some four hundred pages is no mean undertaking. It cannot be expected that the writer will satisfy his critics on all points. No fulness of treatment would probably enable him to do this, and where so much has to be compressed or entirely passed over it is hopeless to think of it. Besides, the questions dealt with are such that at every point he encounters prejudice and runs the risk of wounding the innermost and most sacred feelings. Among these difficulties Prof. Jastrow has tried to find his way. Owing to his charity and sympathy with the most diverse manifestations of the religious spirit, to his circumspection, to his large views of history and to his dispassionate judgment, he has, on the whole, succeeded admirably. His opening chapter on the history of the study, and those on religion and history and religion and culture, display in full measure all the qualities referred to. The practical suggestions contained in the final section deserve careful consideration. In the chapter on the study of the sources the standard is fixed very high. It is well that it should be so. But it is to be observed that the exhaustive study demanded for the religion to which the student proposes to dedicate himself will, in the case of most students, leave but little time for that acquaintance which the writer demands, and rightly demands, with other religions.

"In order to understand one religion," he says, "we must be acquainted with more than one. Religions with literatures differ far more from one another than those which possess none. Hence it is not sufficient to study merely one religion direct from the sources."

By this expression the author means the study of the religious literature in the original tongue. He does not mention, though his illustration of the Hebrew word *goel* evidently implies, a study of the history and culture of the people concerned outside their religion. To continue the quotation :—

"Studying two in this way may be set down as a minimum for acquiring that firmness of method and keenness of judgment needed for the chief problem of religious research—the interpretation of facts. This does not imply that the two are to be cultivated with equal intensity, or that the entire field of both must be covered, but only that in addition to the one religion which forms one's special object of research, one should be able to acquire a sufficient knowledge of a second religion, direct from its sources, as to be able to penetrate into the spirit of that religion."

The ideal is excellent. And yet I am not sure that a more important service may not sometimes be rendered to the study of a religion by one who is ignorant even of the original language, if he be able to bring to bear upon a study of first-rate translations a wide ethnographical knowledge, and therefore to compare the practices of totally different races and cultures. How, for example, would a study of the sources of Hebrew and Egyptian religions, or Hebrew and Hindu religions, even if we add Mohammedanism and Zoroastrianism, enable us to solve the origin and meaning of the rite of circumcision? Robertson Smith could never have written his "Religion of the Semites" if he had been *simply* a student, from the sources, of the Hebrew and Arab religions. A general acquaintance with the results of anthropological study of savage peoples was of more value to him than the study of the literatures of half-a-dozen civilised religions would have been.

I have no space to do more than refer to the cogent arguments with which the author enforces the need for the scientific study of religion in higher education generally, and especially in mission-colleges, or to his exposition of the utility of museums in the study. These chapters, not less than the earlier parts of the book, deserve to be carefully read. The appendices illustrate them by showing actual courses of lectures delivered at the École des Hautes Études at Paris, and the arrangement of the Musée Guimet, which was specially formed to aid the study of religion. To guide the student, a bibliography is added of a remarkably catholic character.

E. SIDNEY HARTLAND.

CHEMISTRY FOR COLLEGES.

A College Text-Book of Chemistry. By Ira Remsen. Pp. xx + 689. (London: Macmillan and Co., Ltd., 1901.) Price 8*s.* 6*d.* net.

THIS book is intended to fill a place between the "Introduction to the Study of Chemistry" and the "Inorganic Chemistry" by the same author. The style and plan of the book may be estimated from the author's remark in the preface, where he expresses the opinion that "The time has not yet come for the abandonment of the study of elements and their compounds in what some are pleased to call the old-fashioned way." Intended, as its name implies, for the use of colleges, the book differs in no essential particulars from other text-books of the same scope. The arrangement adopted for the treatment of the subject is one that has in more recent years repeatedly appeared, a few typical elements and their compounds being studied in some detail in the earlier chapters, and the main bulk of the subject subsequently dealt with from the standpoint of the periodic law. Each descriptive chapter is followed by a number of experiments to be carried out by the student, whose power of observation is aided and developed by the manner in which many suggestive questions are asked concerning each experiment. A number of chapters throughout the book are devoted to a discussion of the principles of theoretical chemistry, and it is in reading these that we are more particularly struck with the loose and inaccurate expressions that are more or less characteristic of the book. Thus it is not the best definition of energy to say that it is "that which causes change in matter." Again, in discussing chemical changes, the student is told to "consider the changes included under the head of fire." Is not fire rather a phenomenon accompanying these changes? In discussing the law of conservation of energy the incomplete statement is made that "from a certain amount of heat we can get a certain amount of motion, and that for a

certain amount of motion we can get a certain amount of heat." In the first place this form of statement is likely to give the impression that heat is something entirely different from motion, and in the second place it implies that heat and motion are quantitatively convertible, which is not strictly true. Further on the statement is made that in order to bring about chemical change "high heat must be used to aid the reaction."

A great number of similar expressions are to be found scattered throughout the book, and it seems a very short-sighted policy to sacrifice accuracy and the use of scientific modes of expression, even in attempting to make matters more intelligible to beginners, as it is far more difficult to get rid of early false impressions than to acquire correct ones in the first place. This sort of treatment is especially to be noticed in the author's account of the ionic theory. On p. 90, ions are first introduced very briefly to the notice of the student, and throughout the succeeding pages many reactions are represented as due to action between the ions; and equations are printed in which the ions are represented as atoms. This must be exceedingly confusing to the student who has been told in another place that atoms, generally speaking, cannot exist in the free state; and it is not until p. 417 that this difficulty is overcome for the student by the true explanation of the nature of an ion. Another serious misstatement occurs in the account of the phenomena of osmotic pressure, where, after quoting the extension of Avogadro's law to solutions, the following passage appears: "Notwithstanding the simplicity of this law, no practical method for determining molecular weight based upon it has yet been devised."

The more descriptive part of the book is also not free from inaccuracies. For example, in one portion of the table on p. 15 the atomic weights are referred to $H=1$, in another part of the same table to $O=16$. The term combining weight is itself used in two different senses in different parts of the book; in the earlier portion it is used as synonymous with atomic weight, and in the later portion as a simple submultiple of the latter. Another discrepancy is that which ascribes to krypton on p. 19 the atomic weight 81·8 and on p. 262 58·67. It is disappointing to find the author of so excellent a work as the admirable little book on organic chemistry failing to come up to the standard of accuracy which is now demanded of teachers.

HYDRAULICS.

A Treatise on Hydraulics. By Henry T. Bovey, M.Inst.C.E. Second edition, rewritten. Pp. xviii + 583. (New York: John Wiley and Sons; London: Chapman and Hall, Ltd., 1901.)

THE author of this treatise, in his position of professor of civil engineering and applied mechanics at McGill University, Montreal, has exceptional opportunities for conducting experimental investigations on the flow of water, owing to the remarkably complete equipment of the hydraulic laboratory under his charge, which the University owes, in addition to many other endowments, to the munificent liberality of Sir William C. McDonald, a well-known merchant residing in Montreal. It is very satisfactory to note that Prof. Bovey has made full use of his opportunities in advancing the study of hydraulics, as indicated, in the first instance, by the publication of the first edition of this book in 1895; whilst this second edition, with its rearrangement, its large quantity of new matter, and its additional tables of experimental results, marks the progress which has been made in the interval towards raising the subject of hydraulics, so long based on empirical formulæ, into the position of an exact science.

The subject is divided into eight chapters, to each of which, in addition to examples worked out in the text, is appended a number of problems for the student, relating to the questions dealt with in the chapter, together with their answers. The book begins with a chapter on general principles and the flow through orifices and over weirs, followed by one on fluid-friction and pipe-flow, and another on the flow of water in open channels; and these three chapters, each extending over more than a hundred pages, complete the portion relating to the flow of water, and occupy more than half the book. They furnish a fairly exhaustive treatment of the subject; but though, owing to the large print, the widely-spaced formulæ, the numerous diagrams, and the tables, the actual contents of these chapters are not so great as might be inferred from the number of pages they occupy, the chapters are inconveniently long, and might with advantage have been subdivided. This is undoubtedly the portion of the book to which civil engineers engaged in water-works, irrigation, and river improvement will mainly refer for an elucidation of the difficulties involved in the correct determination of the flow of water through orifices, over weirs, along pipes, and in open channels. A chapter is devoted to the important subject of hydraulic machinery, including rams, presses, accumulators, and water-pressure engines. Three chapters relate to water-motors, dealing successively with impact, reaction, and the principles of impact and tangential turbines, vertical water-wheels, and turbines; and the final chapter deals with centrifugal pumps. The book is illustrated by three hundred and thirty figures in the text, mainly diagrams for elucidating the various theories and principles dealt with, together with a few drawings of machines referred to; whilst a very convenient paged list of the various headings of subjects throughout the book is given in the table of contents at the commencement, and a concise but useful index concludes the volume.

The mathematical treatment adopted right through, with the four hundred and forty-six examples given for working out, render the book more especially suitable for students in hydraulics who have had a previous mathematical training, the book having, indeed, been originally the outcome of a series of lectures to such students; and it will be doubtless of interest to hydraulicians, particularly in view of the advance it manifests in hydraulic science. A less elaborate and less educational method would probably have more favourably commended the book to the notice of practical engineers interested in hydraulic problems; and, in its present shape, the book seems likely, irrespective of its value to hydraulic students, to be mainly advantageous to those engineers

in practice who possess adequate mathematical knowledge and leisure to select from the numerous formulæ, and especially from the tables, those portions which are best adapted for practical application. It appears really almost impossible to produce a treatise on such a subject as hydraulics, so that, whilst furnishing an exhaustive treatment of the subject and being of considerable educational value for the advanced mathematical student, this book should, according to the author's hopes, at the same time prove specially adapted to the requirements of busy practical engineers; for in proportion as it realises its main object, it tends to become unsuited for its secondary purpose. Nevertheless, as a book tending largely to advance the science of hydraulics and promote the thorough training of future hydraulic engineers, it deserves to be very cordially welcomed.

OUR BOOK SHELF.

Erlebtes und Erstrebtes. Von Carl Gegenbaur. Mit einem Bildniss des Verfassers. Pp. 114. (Leipzig: Wilhelm Engelmann, 1901.) Price 2*s.*

THERE must be many who have hailed with delight the announcement of "Erlebtes und Erstrebtes," the authentic account of the long and assiduous life of the founder and elaborator of modern comparative anatomy. However, the readers of the little brochure will be sadly disappointed, since it contains not much Erlebtes, and the author is more than reluctant about telling us what he has "Erstrebt," *i.e.* striven for and reached. Most of the reminiscences can be of interest only to his own family. Born at Würzburg August 21, 1826, sprung from a family of mostly Governmental officials, mainly of Bavarian descent, Gegenbaur went through his schooling at Würzburg and spent the vacations roaming about with his gun, dissecting his spoil. He is emphatic about the value of the studies of the classics; "to ignore the classical languages means to resign part of our education, and those who say that these languages are dead, ought to remember that the letter killeth, but the spirit giveth life." Würzburg was also his university, where, after eighteen months of preliminary philosophical and historical studies, he was inscribed as a medical student. In the same year, 1847, Albert Koelliker was called to the university. F. Leydig was privat docent for microscopical anatomy, and for him our author has high praise. Another of his teachers was R. Virchow, "whose great merit is that he gave a new, very fertile, direction not only to pathology, but to the whole of anatomy, by imparting to it the notion of evolution."

Gegenbaur studied with a view to following natural sciences, not to devote himself to medicine, which latter he could not bring himself to consider a true science. Still, he became third assistant at the Julius hospital. In 1851 he took his degree, one of his theses dealing with the changes and variations of plants. Then followed his "Wanderjahre," visits to the chief German towns, and in Berlin he made the personal acquaintance of Joh. Mueller. In 1852 he went with Koelliker and Heinrich Mueller, of retina renown, to Messina, bent upon zoological research, and he wandered through Sicily, in which island he spent nearly a year.

In 1854 Gegenbaur established himself as privat docent for zoology at Würzburg, soon to leave this place for Jena as professor extraordinarius. At the death of Huschke he became the latter's successor as professor of anatomy. This was the first university in which henceforth anatomy was separated from physiology, a science for which he has not many kind words to say. Berlin followed suit in the same direction after the decease of Joh. Mueller, then Würzburg, &c.

In 1856 he married his first wife, whom he was to lose soon after; we are not told that she was a daughter of Huschke. From this time dates the intimate friendship with Haeckel. The author speaks with warmth of quiet little Jena as the place where practically all his fundamental ideas were conceived and grew. He set himself to rescue anatomy from the state of mere description; the term morphology in opposition to physiology "was intended mainly to express the difference of treatment," and anatomy itself was to be elevated to a higher position by the comparative method.

In 1873 Gegenbaur went to Heidelberg as the successor of Fr. Arnold, his second father-in-law. The following twenty-nine years, so full of activity and world-wide influence, are dealt with in ten small pages—the writing of the text-book of the anatomy of man (now in its seventh edition), based upon the results of comparative anatomy; the starting of the long series of the "Morphologische Jahrbuch," and scanty reminiscences concerning, and of interest to, but a few intimate friends.

The book is prefaced with an excellent likeness of the author.

H. G.

Beautiful Birds. By Edmund Selous. Pp. ix + 224. (London: Dent and Co., 1901.)

MR. SELOUS' volume, in spite of its pleasant-looking green cover, numerous though indifferent plates, and text cheerfully varied with italics, is in reality no more than an unduly swollen tract. It is necessary to say this at once, and with emphasis, lest the unwary buyer of bird books should add this volume to his library under the impression that he was adding a useful and chatty account of humming-birds and birds of paradise. The volume is, in fact, an example of what is known in the animal world as "aggressive mimicry." Under the guise of a pleasing discourse upon some of the more striking among many beautiful birds, the author really provides the public with not much more than a simple attack upon the wearing of birds' plumes by ladies. We have not the least objection to Mr. Selous' views in this matter, or to the expression of them. But he might surely have found one of those numerous journals which delight in denunciatory declamation rather than in adherence to frigid fact, and into its sympathetic columns have poured his feelings of horror at feminine inhumanity. Then no one would have been deceived about the matter, as some possibly may be. Mr. Selous builds upon a minimum of zoological fact a large superstructure of curiously agitated, almost hysterical, ethics. The book is, in its form, addressed to a hypothetical and female infant of tender years who is urged to persecute her mother and female relatives generally until they promise never to wear birds' feathers in their hats, as, for instance—"You must remind her of it from time to time ('remember mother you promised'), when you hear her talking about getting a new hat. And when you have made her promise about herself then you must make her promise never to let you wear a hat of that sort. . . . And if you have a sister very much older than yourself, &c., &c." With such observations the chapters are liberally sown and nearly invariably conclude; it is, moreover, at least once added that the mother and sisters in question had better read this particular volume. We sincerely hope that they won't take this broad and business-like hint; for even from the point of view of a "humanitarian" (we must use inverted commas as there is no necessary connection between the use and meaning of this term) Mr. Selous is unworthy of praise. Why should he select the "beautiful birds" only, and by implication condone the massacre of birds that have not that advantage?

F. E. B.

Lehrbuch der Chemie und Mineralogie. By Prof. G. Siebert. 3 vols. Pp. viii + 101, vi + 144, vi + 110; figs. 100, 91, 32. (Braunschweig: Friedrich Vieweg und Sohn, 1901.) Price Mk. 4·25.

THIS text-book, which is intended for use in higher schools, does not differ to any very remarkable extent from numerous other elementary treatises on the same subject. Perhaps the first volume, described as an introduction to chemistry and mineralogy, shows the most originality in treatment. In this part the beginner is made acquainted with the most important chemical processes, such as oxidation and reduction, and is taught something of the more common chemical compounds, mainly by means of experiments, of which a hundred are fully described. These experiments are in most cases quantitative, and involve the weighing of gases as well as of solids and liquids. The laws of chemical combination which receive their expression in the atomic theory are thus impressed on the student by his own actual quantitative results. The treatment of the mineralogy is of a somewhat perfunctory character. The six systems of crystals receive the usual brief and inadequate exposition common to chemical text-books, and the Naumann system of notation for the crystal-faces is explained, but no mention is made of Miller's system. A review of the most important minerals appears at the end of the volume, and brief descriptions, with figures of the crystals, of natural phosphates, sulphates, &c., are given in their appropriate places in the text. The second volume is devoted to inorganic chemistry, and the elements with their principal compounds are treated in turn, the non-metals in the order of their valencies, and the metals in the usual groups. The third part deals with organic chemistry. Structural formulæ are explained, but the treatment is sufficiently elementary, as is evident from the fact that the whole subject of both fatty and aromatic compounds occupies less than a hundred pages. In an appendix are given the descriptions of a number of simple experiments illustrating the methods of production and properties of some of the most important organic compounds. A very brief introduction to organic and volumetric analysis completes the volume.

Knowledge. Vol. xxiv., January to December, 1901. Pp. xii + 288. (London: *Knowledge* Office.) Price 8*s.* 6*d.*

SOME of the full-page photographic plates in this volume of *Knowledge* are very fine. Among the subjects are several brilliant photographs of star clusters and nebulæ, taken by Dr. Isaac Roberts, constellation figures on Greek coins, lunar photographs, life-history of a sun-spot group, spectra of Nova Persei, and the solar corona of May 18, 1901. Mr. E. W. Maunder has a series of articles on constellation studies, in which he deals largely with the poetical aspects of the sky; Dr. Vaughan Cornish has four articles on the sizes of ocean waves; Mr. G. H. Carpenter describes insects of the sea; Mr. R. Lydekker writes on a number of subjects of zoological interest; Mr. H. F. Witherby on ornithological experiences in the Soudan; and Mr. R. Lloyd Praeger on flowering plants. There are numerous other articles of an instructive character.

A Geography of Wales. By A. E. L. Hudson, B.A. Pp. xii + 164. (London: Macmillan and Co., Ltd., 1902.)

THIS book is intended chiefly for use in Welsh schools, and the general idea borne in mind in its preparation is that the best foundation for a knowledge of geography is the study of the land and the people of the district and country in which the pupils live. The attention given to physical geography and to civic affairs, such as local and national government, and population and its distribution, is noteworthy. There are many attractive illustrations, which, with the instructive text, will serve to commend the book to the attention of teachers.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

Fall of Mud or Dust.

MY men here noticed on Thursday last the 23rd inst. that the leaves, glasses of the frames and iron work of the gates were smeared with a reddish mud; one hedge in particular they described as almost covered with the substance; and the pinafores of a cottager's children which were hanging out to dry were so stained with the deposit that they had to be rewashed. When the substance fell no one here knows, nor is it clear whether it fell as dust or mud; from the firm way in which it has attached itself to the iron work I should think that it fell as mud.

Unfortunately, I did not hear of the event till some days afterwards, and I first saw the deposit yesterday. It was still, notwithstanding a good deal of rain, to be seen on the iron work, the glasses of the frames and on leaves. I send for your inspection herewith a laurel leaf, down the sides of the midrib of which you will find some of the deposit in question. Possibly some expert may be able to determine the nature of the deposit. It does not appear to me to be silica.

I append cuttings from local papers, showing that the phenomenon was observed elsewhere. Lawrence Weston is some five miles north-east from hence, Chewton Priory some fifteen miles south-east, and Barry Island some twenty miles west-by-south and on the other side of the Bristol Channel.

Failand, January 28. EDW. FRY.

From the *Bristol Times and Mirror*, January 21.

A CURIOUS STORM.

SIR,—I thought the readers of your valuable paper would be interested to know that on Thursday morning we had what I think a rather strange storm, about a quarter past seven, of about 15 minutes' duration. After it got light I found quite a covering of dust on the glass on the garden frames, about the colour of Bath brick dust. Not having seen any account of it in your paper, I thought I should like to hear if anyone else had noticed it. Yours truly,

Lawrence Weston, Henbury, January 24. A. DENHAM.

From the *Western Daily Press*, January 28.

SINGULAR PHENOMENON.

SIR,—Seeing in your paper of yesterday's date a paragraph about a mysterious red substance which fell at Barry Island on Wednesday last, I write to say that a somewhat similar phenomenon occurred here.

Wednesday the 22nd was with us very warm, with wet mist only measuring 0·02 of rain. Afterwards the glass and wood-work of the greenhouses and frames were covered with a rust-coloured dust, which has left stains on the paint.

Yours faithfully,

Chewton Priory, Bath, January 26. WALDEGRAVE.

Change of Pitch of Sound with Distance.

I HAVE read with considerable interest the letter by Mr. Paul R. Heyl on this subject in your issue for January 23. Speaking off-hand, I should have agreed with Mr. West, that pitch rises with distance; but, in view of the experience of your later correspondent's grandfather, I am inclined to adopt the contrary view. Many years ago I was sitting with an organist friend listening to a fugue on an organ—I think the player was the late Mr. Thomas Adams, and the fugue one of the immortal "Forty-eight" of Bach. At any rate, it was in a minor key; but I noticed that the last chord was *major*. "Why," I asked my friend, "does he end with a major chord?" "Because," was the reply, "sound has a tendency to rise in a long building like a church, and therefore the writer anticipated this by writing his final chord with a major third." But was this the reason? If the late Mr. Knauff was right, it was probably to allow for the third dropping, and the chord reaching the listeners as a minor chord, in keeping with the rest of the piece.

Of course, everybody knows that the practice above alluded to of ending a minor piece with a major chord is by no means uncommon with Bach. For example, in his "Grosse-Passions-Musik," the chorus which follows the duet, "My Saviour Jesus now is taken," ends (according to the English version by Miss Johnston) with the words, "the treach'rous betrayer, the murderous throng." Bach has reiterated them—the first time with a minor chord (E), with G natural, on the word "throng"; the second time with a chord on the same key-note, but with a *major* third (G sharp) and a pause. The effect is thrilling. Surely there could have been no allowance for drop here. Handel, on the contrary, begins and ends his chorus, "And He shall purify," in the "Messiah," in G minor, although the two succeeding pieces are in D major, with which key the previous piece would have been brought into relationship by the raising of the third.

This is a digression from the subject of your correspondents' letters, which probably never entered the minds of the great masters named. R. FREEMAN.

London, February 3.

A Lunar Romance.

IS not Mr. Wells right in the description of the effect referred to by the reviewer of his "First Men in the Moon" (p. 218)? The *sphere* itself, as a whole, is *not* attracted by gravity. The action of gravity has effect only in the line (?) through the open window, and, *quâ* the sphere, would only affect that part which would be directly in a straight line from the moon through the window. F. C. CONSTABLE.

Wick Court, near Bristol.

IN answer to Mr. Constable, I think we cannot allow that the sphere is not attracted by gravity. I understand it to be a sphere of solid glass, PQ, inside a cavorite covering, RS (Fig. 1).

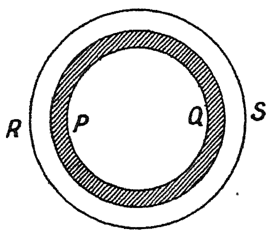
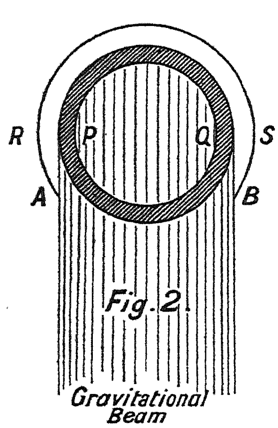
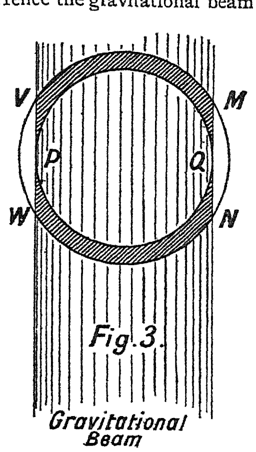


Fig. 1.

In the case considered, the covering is removed through a wide angle AB, thus described (p. 62): "Four windows were open in order that the gravitation of the moon might act upon all the substances in our sphere." Hence the gravitational beam





reaches the whole of the glass sphere itself (Fig. 2); unless (Fig. 3) Mr. Wells means to reserve little pieces, VW and MN, at the sides outside the beam. In this case the total mass of the sphere remains the same, but is not all acted on by gravity; so that the acceleration of the whole would be *less* than *g* (in the ratio of mass acted on to total mass), *i.e.* less than that of objects within, which would promptly settle to the "floor."

If Mr. Wells was thinking in this subtle fashion I withdraw my criticism, and Mr. Constable will see that I have left an open door for myself in the review for withdrawal. I may say it was left open expressly in view of this possibility. But the context does not suit this view at all well.

THE REVIEWER.

Cherry Leaf Disease.

THE question raised by Sir W. T. Thiselton-Dyer's letter is a very important one, and I venture to offer a few observations on it.

It is impossible that Mr. Bennett—still more Mr. Carruthers—could have intended to suggest that the experts at Kew and the British Museum are not competent to investigate such diseases as the above when they are submitted to them. They probably meant that an organised system is wanted in every county, by means of which an outbreak of any such disease should be at once brought under their notice. This could only be satisfactorily done by local inspectors, who would be in touch with the farmers on the one hand and the experts on the other. It should be part of their duties to keep accurate records of temperature and rainfall in order to show the connection, if possible, between these and the disease. These officials would naturally be appointed and paid by the County Council.

As regards the outbreak of Gnomonia mentioned by Sir W. T. Thiselton-Dyer, it is a curious fact that in most of the orchards about here affected by it in 1900 the disease has almost disappeared, though no preventive measures such as stripping the leaves were taken. It would, however, be very unfair to blame the advisers of the Royal Agricultural Society for raising a false alarm; in the case of a disease not known to have occurred in this country before, they were clearly bound to act upon the best information they could get—that of Frank—and warn the farmers. The more equable climate of England, as compared with Germany, is probably the cause of the different result, the effects of comparatively small differences of temperature and moisture being vastly more important than is generally believed.

ALFRED O. WALKER.

Ulcombe Place, near Maidstone, February 2.

Extremes of Climate in the British Empire.

YOUR correspondent (p. 299) who writes under this head in the current number of NATURE would make the labours of an editor as super-Herculean as those of the Highland minister who was called upon to incorporate the whole body of divinity in every sermon lest his flock should be misled.

That it would be wrong to generalise on the climates of the British Empire from eighteen stations, or to claim any one of them as the hottest or the wettest point, is obvious; but even in the few lines of your abstract you have not done this, and in my original summary (*Symons's Meteorological Magazine*, November, 1901, p. 167) I said:—

"It is true that neither the hottest, the coldest, the wettest nor the driest points in the Empire are dealt with; and the reader is warned, as on each previous occasion of presenting this annual summary, not to take the figures as meaning more than they profess to convey."

In order to secure continuity in the records, which are published monthly, it is necessary to obtain them from regular observatories: these are, unfortunately, few; but, fortunately for the student of climatology, they are usually situated in districts of normal rather than of extreme climate. Additional observations would certainly be welcome, and I hope during the present year to be able to publish monthly records from at least twenty-five stations in all the Britains.

HUGH ROBERT MILL.

62 Camden Square, London, N.W., January 31.

Elementary School Mathematics.

IN connection with the present discussion on the teaching of elementary mathematics in schools, and the recommendation made by many experienced teachers that much use should be made in geometry—at any rate in the earlier stages of actual

measurements of lengths of lines, may I suggest that such measurements should always be made in centimetres? A handy steel rule, six inches long, graduated both in inches and tenths, and in centimetres and millimetres, can be bought for a few pence, and is easily carried in that almost omnivorous receptacle—the pocket of a schoolboy. The use of such a rule would beget familiarity with the metric scale, in itself an advantage for any boy whose education includes some knowledge of elementary physics. But more—the schools of the country would soon be sending out each year a body of educated men acquainted more or less with the advantages of the metric system, and their influence can scarcely fail to be helpful in hastening the general adoption of the metric system—a change so much to be desired both in education and in practical life.

Fettes College, Edinburgh. JOHN S. YEO.

Electrification of Glass.

REFERENCE is commonly made, in text-books of electricity, to the uncertainty of kind of the electrification produced on glass when it is rubbed with fur or flannel, opposite results being obtained with different specimens.

The following is a variation which I have not seen mentioned. A strong positive charge may be given to a smooth rod of soda-glass, by rubbing it gently with a certain piece of fur. Vigorous rubbing, on the other hand, produces an equally good negative electrification. Thus the two sorts may be produced in quantity at one stroke, by making the friction small at first and finishing with a vigorous pull. The half-way region of zero electrification may be displaced at will.

A piece of lead glass seems to be always positively electrified by this particular piece of fur. F. HODSON.

North Eastern County School, Barnard Castle, January 28.

THE DANGEROUS SIDE OF INDIA.[1]

AT the present time much interest attaches to the North-West Frontier of India, and to Afghanistan, the Beluch country and the Persian Gulf. Sir Thomas Holdich's book, therefore, is opportune as well as of remarkable value. It must be carefully studied by everyone desirous of forming an intelligent opinion about our Indian frontier policy. The politician, the military expert, the dilettante student, the thoughtful citizen of the Empire, all will gain much from its well-written pages. Moreover, although the chief and permanent value of this admirable work is topographical, the general reader merely in search of mental enjoyment will find a peculiar pleasure in the vivid descriptions of stirring incident and picturesque countries. The style is always easy and graceful, while it rises frequently to singular eloquence and poetry. Rarely are sound knowledge and expert opinions offered to the public in a form at once so simple and attractive.

A cultured survey officer of the Indian Service has clearly very enviable opportunities for varied experiences; but it requires a quiet observant mind, sanitary with humour, to vitalise scenes and peoples as they appear in this record of twenty years' work on the restless Indian frontier. Of the various districts and wild folk shown to us, some are more especially in one's thoughts at the present moment. The political temperature of parts of the Punjab frontier is just now simmering or even ebullient. In Swat there is the outward aspect of peace without cheerfulness. How much this is due to the dominance of our big battalions in that historic valley and how much it is due to the vast number of strong fighting men, fierce of heart and light of foot, who were killed there during the 1897-98 uprising it is hard to decide. No one, however, seems to assert that the people like our presence among them. When the sullen youths shall be grown enough to strike another blow for Islam, we may expect more trouble in that sickly district, especially if the garrison is diminished. The less fanatical Orakzais and Afridis sit complacent, but watchful. Satisfied with their last display of fighting prowess, they are ready, on the instant, to rush to the rally if their freedom of rascality is threatened or their subsidies are reduced. Further south, in Waziristan, we have gone back to the old plan, the ancient way, of surprise and counter raid, the burning of homestead and tower. Also in the organisation of the new frontier province, of which so much has been written, Lord Curzon has reverted to more primitive methods. Complex forms of administration have been replaced by a rougher, not necessarily less efficient system. The mere lawyer and the pleader are beggared in importance, and the "political officer," raised aloft in power, is to be mantled with responsibility. It is admittedly a putting back of the clock. Curious, not always friendly, eyes watch the experiment. Its success mainly depends upon the attractions dangled before the eyes of able officials to draw them from easier days, and domestic joys, to rugged solitary work in desolate places. Beluchistan is placid and peaceful. It is the more primitive type of frontier management. To this simple pattern the new frontier province is to be retrograded by the forcible suppression of many functions and recent developments, which until now were gloried in as triumphs of British rule in India. But not only are the political and ethnological conditions of Beluchistan and the new frontier province dissimilar, but a Sir Robert Sandeman is not the product of every day.

Then behind all these borderland experiments stands dubious Afghanistan watching curiously its new Amir, full of conjecture, moreover, about the refugee pretender in the hands of the Russians, and that other refugee pretender, the honoured guest of the British at Rawalpindi. It is no easy task to rule the turbulent, faithless Afghan tribes, and the peaceful succession of the present ruler of Kabul may be followed at any moment by some wild upheaval of ambition or of revenge on the son for the savage repressions of his father. Herat, and the Russians peering wistfully at that coveted if somewhat corroded "Key of India," must always be of anxious interest to all students of the Afghan frontier and to all lovers of peace.

To understand the real value to India of all these differing countries, and to estimate accurately their relative importance, a thorough comprehension of Sir Thomas Holdich's facts and geographical opinions is an essential precedent condition. He has something important to say on all the pressing questions concerning the north-west limits of India, some solid physical basis to disclose or to explain, ignorance of which must make reasonable conclusions impossible. That strange diplomatic instrument the "Durand" treaty has a chapter to itself. Surely no more curious or less sincere arrangement was ever concluded between the Government of India and an adjoining Power. By it a definite frontier line has been laid down and actually demarcated. On one side of this line the Amir is to maintain order and never again to throw covetous glances beyond the boundary pillars which define its course. We, on our part, accept responsibility for all the independent tribes which intervene between the pillars and our Punjab territory. The Amir can fulfil his promises, while obviously we can only keep to our agreement by first subjugating this wild mountain land. Misdemeanours against Afghanistan by the tribes nominally under our responsibility, but actually uncontrolled by us, can only be punished by the Amir sending raiding parties into the very country he has promised not to enter. We have to wink at these flagrant violations of a solemn treaty because we ourselves never had any intention of obeying its terms.

Such loose acceptances of frontier responsibility are,

[1] "The Indian Borderland, 1880-1900." By Colonel Sir T. Hungerford Holdich, K.C.I.E., C.B., F.S.A., late of the Indian Survey Department. Pp. xii + 397. (London: Methuen and Co., 1901.)

in a political sense, immoral as well as practically mischievous. Already terrible evils have followed. The independent tribes, on our side of the limit, believe that in 1893 we annexed their hills, and only now refrain from a military occupation because of the martial prowess of the clansmen. All the frontier wars and the exacerbation of fanaticism all along the line since 1893 are traceable directly or indirectly to this unlucky treaty. Implacable suspicion and armed watchfulness on the part of the highlanders, as well as those violent outbreaks which have cost us so dearly, are part of the price which we have already paid for a false policy, not justified even by the seeming expediency of a critical time.

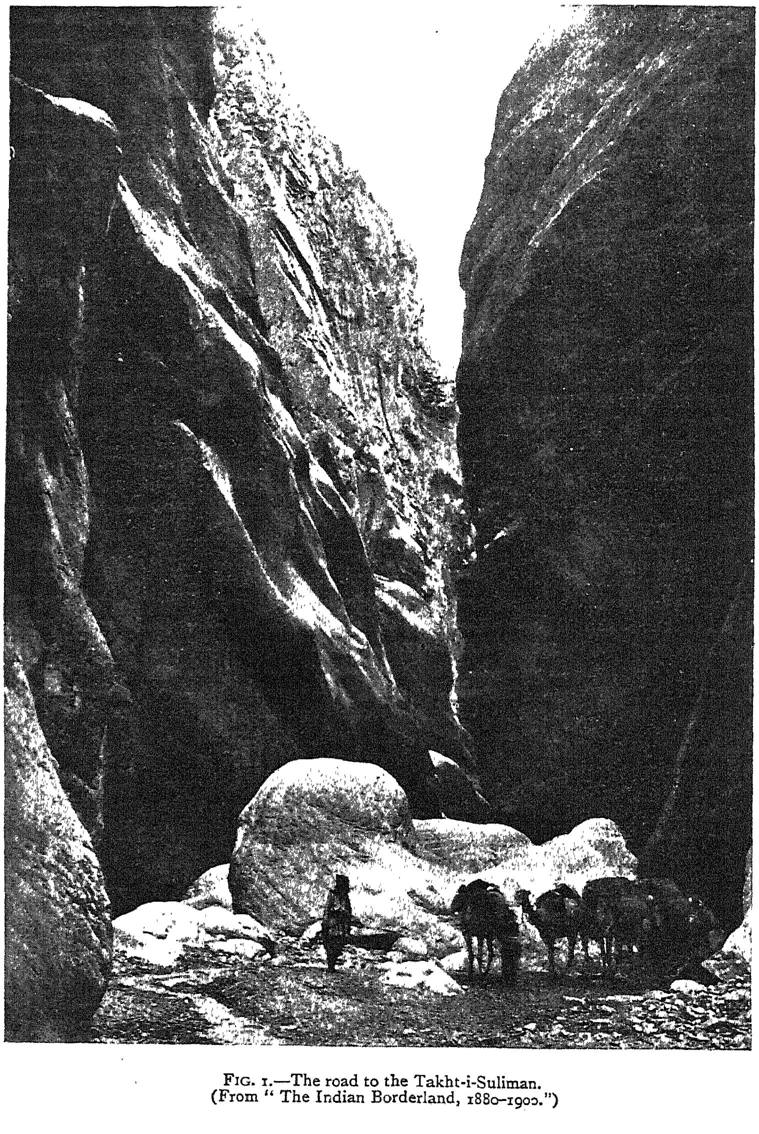


FIG. 1.—The road to the Takht-i-Suliman. (From "The Indian Borderland, 1880–1900.")

Of Makran, the Persian Gulf, and that place of contention, Koweit, Sir Thomas Holdich has very pleasant and instructive pages. Quite apart from the "professional" value of his judgments and his historical summaries, there is a graphic power in his descriptions which stamps the strange scenes deeply in the mind. Here, as in all his other wanderings, this genial, able Royal Engineer officer displays his love of nature's beauty. This makes his book, not only the most important publication of the time on the Indian frontier, but also the most agreeable to read. The illustrations are excellent, the map trustworthy and very useful.

REPORT OF THE INDIAN PLAGUE COMMISSION.

THIS report, consisting of five big volumes, is a record of the work of the Commission appointed by the Governor-General in Council, with the approval of the Secretary of State for India. The questions submitted to the Commission were four: (1) the origin of the different outbreaks of plague (in India); (2) the manner in which the disease is communicated; (3) the effects of curative serum; and (4) the effects of preventive inoculation.

The Commission, with Prof. Fraser, F.R.S., as president, has collected in seventy meetings in different parts of India and in two additional meetings after their return in London, the stupendous amount of evidence embodied in three closely-printed large volumes in twenty-seven thousand questions and answers.

The summary of the conclusions arrived at by the Commission, after having examined a host of competent witnesses and after having carried out itself or directed a considerable amount of work concerning plague, is contained in vol. v. on more than 500 folio pages. From this it will be understood that the work of the Commission was carried out in a thorough manner. Add to this the fact that the Commission had prepared a large amount of work in the form of charts, tables, statistical summaries, &c., and that after repeated and lengthy discussions amongst themselves the commissioners remained divided on several important points. We mention this to prepare the reader of the report for the surprise of not finding specific answers to the specific questions put to the Commission. This surprise is to a certain extent justified if we remember that various foreign commissions—Russian, German, Austrian, French—who have been sent out to India or Oporto respectively to study plague have in their reports given their Governments to understand that they have satisfactorily solved all and every problem concerning every point of the disease plague.

One has only to look through vol. v. of the report to feel convinced that the Commission has striven assiduously to find the specific answers; every page of this volume testifies to the desire to arrive at the correct conclusion; every assertion of fact brought before it was judicially and critically examined, compared and adjusted to its proper place and bearing. There can be, therefore, no question as to the thoroughness of the work itself. The cause of the deficiency of the answers must be sought elsewhere. In looking at the evidence of the witnesses and at the observations of

the commissioners themselves, it will be seen that the answers were not found, partly because the data to hand were insufficient and partly because the problem of plague in India is of far greater complexity than we were led to expect, and because there were too many unexpected difficulties encountered by the Commission.

If one reads some of the self-sufficient conclusions of some modern writers on plague (including the above-mentioned reports of the foreign commissions), one is met by the apparent simplicity and seemingly satisfactory solution of the problem concerning the etiology, epidemiology, prophylaxis, treatment, &c., of plague; and yet here we have a commission, consisting of a number of the most able and highly qualified experts, examining, experimenting, criticising and discussing, and at the end of their labours they either fail to give a specific answer to the specific questions asked, or they are able to do so only in a fragmentary manner and under certain restrictions. The commissioners have not been able to trace when, whence and how plague came into Bombay; the commissioners are not able to state the manner in which plague was imported and how it spread in many localities in India; the commissioners are not able either to condemn or to recommend the use for therapeutic purposes of either Lustig's serum or Yersin's serum; and the commissioners express a not markedly decided, although on the whole a favourable, opinion about Haffkine's plague prophylactic. Although definite answers by the Commission to the four specific questions could not be given, many valuable opinions and facts concerning plague in India have been placed on record.

In the first place, the Commission distinguished the mild (or ambulating) form of true bubonic plague from the severe form, the former as "pestis minor," the latter as "pestis major." This is a timely and important statement, because recently some "plague experts" have tried to raise some febrile disease associated with glandular swelling, but which, according to their own showing, is not plague, that is to say, is not caused by the *Bacillus pestis*, to the position of "pestis minor," thereby creating and fostering misunderstanding.

Another important point is the confirmation by the Commission concerning the great importance of "locality" in the dissemination of plague (vol. v. p. 101). "The universal experience of plague in India proves . . . that houses into which the infection of plague has been imported, whether by man or by rats, are infective, this infectivity being so marked that many of the officers who have had most experience of the disease have come to the conclusion that the principal source of infection is . . . to be found in the houses into which the infection of plague has been introduced."

Unfortunately, the Commission did not find sufficient data to explain the nature of this factor. Equally unsatisfactory results attended the discussion as to the importance of rats in the dissemination of plague amongst human beings. But as regards the reality of the danger of clothes and personal effects of plague-infected persons in transmitting plague to new "localities," the Commission is very emphatic.

Not the least valuable part of the report consists in the indication of the nature of further work required for elucidating many of the points at present unsolved. Amongst these is the encouragement of further experimental work in the more accurate study of the blood of animals which furnish curative serum, and the importance of such work in obtaining a uniform strength and accurate standard of Haffkine's plague prophylactic.

E. KLEIN.

A. W. BENNETT.

ALFRED WILLIAM BENNETT, M.A., B.Sc., F.L.S., the well-known lecturer on botany at St. Thomas's Hospital, and for many years a prominent figure in botanical circles, died suddenly from heart disease on January 23. Born at Clapham in 1833, Mr. Bennett took the degree of B.A. (Lond.) in 1854, and afterwards spent ten years in business as a publisher. During this period he employed photography in the illustration of books, and was one of the first, if not the first, to do so. Shortly after taking his M.A. degree he had the misfortune to fall from a horse, an accident that somewhat seriously affected his health throughout his subsequent life. When the publication of NATURE was commenced, Mr. Bennett was appointed as the first sub-editor, and he occupied that postion for several years. He received the appointment of lecturer on botany at St. Thomas's Hospital nearly thirty years ago. Botanical students will remember Mr. Bennett as the translator of the third edition of Sachs's classical "Lehrbuch der Botanik" and of Thomé's Lehrbuch. His enthusiastic study of the flora of the Swiss Alps found expression in some important works for the use of students of Alpine botany. His translation of Dalla-Torre's "Tourist's Guide to the Flora of the Alps" was issued in 1886, and previously he edited Seboth's "Alpine Plants Painted from Nature," a work in four volumes. His useful "Flora of the Alps," in two octavo volumes, accompanied by 120 coloured plates, appeared in 1897. He devoted much attention to the Cryptogams, as witnessed by the excellent "Handbook of Cryptogamic Botany," a work executed in conjunction with Mr. George Murray and published in 1889. With regard to the systematic study of the Phanerogams, Mr. Bennett confined his labours chiefly to the Polygalaceæ, which he monographed for the "Flora of British India" and the "Flora Brasiliensis," dealing with the order also in some important papers contributed to the *Journal of Botany*. In the Royal Society's Catalogue of Scientific Papers he appears as the sole author of forty-six papers, many of which are based on his observations respecting the fertilisation of flowers. Elected a fellow of the Linnean Society in 1868, he served for some years on the council of that society, and was one of the vice-presidents for 1891–92. He was also a fellow of the Royal Microscopical Society, of which he was a vice-president in 1899–1900, and the editor of its *Journal* since 1897.

S. A. S.

NOTES.

AN influential committee has been formed with the object of establishing a memorial tower and meteorological station in honour of Dr. J. P. Joule, F.R.S., at Sale, Cheshire, where he lived from 1872 down to the time of his death in 1889. Sir W. H. Bailey has offered to the Sale District Council an automatic recording meteorological and public clock made from designs which are the result of his investigations and inquiries with regard to similar instruments in this country and abroad. The instrument will be unique in its details; will indicate the time as a public clock on large dials, produce automatic graphic records of the various changes of temperature and the fluctuations of atmospheric pressure, and also changes of the wind and the rainfall of the district. In addition to this gift, which will cost about 250*l.*, Mr. F. Armstrong has offered to the Council a set of instruments to equip a meteorological station, and the only condition attached to these gifts is that they shall be suitably housed. Designs for a building to be called "The Joule Memorial Tower," to contain the recording and other instruments, have been prepared, and the Council is willing to

permit the erection of such a building in the public park and recreation ground. In a room at the base of the building the meteorological instruments will be placed, and on one side of the exterior a tablet will be fixed on which there will be set a medallion portrait of Dr. Joule and a short record of his titles to fame. The cost of this tower will probably be 1000*l.*, which sum the District Council would have been willing to provide had its funds been applicable for such a purpose. As this course was not practicable, a committee has been formed at the instance of the District Council for the purpose of obtaining subscriptions to raise the amount required. Subscriptions should be sent to the hon. treasurer (Mr. A. H. Megson, The Priory, Sale), or the hon. secretary (Mr. J. W. Robson, Selbourne Lodge, Sale).

THE Royal Institution has received the following relics of Michael Faraday, bequeathed to it by the late Mr. Thomas J. F. Deacon, of Newcastle-on-Tyne:—Medals of silver and bronze (numbering twenty in all), and including the Fuller medal of 1828, two Copley medals of 1832 and 1838, two Newton medals of the Royal Society, 1833 and 1838, and the Rumford medal of 1846; and two foreign Orders, contained in a small mahogany box; a book of portraits and autographs, including original letters from the Prince of Wales and Prince Alfred (written in 1856), Louis Napoleon, Emperor of the French; Humphry Davy, Thomas Young, Humboldt, John Dalton, Whewell, Mary Somerville, and many others; a daguerreotype of a consultation of Faraday with Prof. Daniell; a drawing in colours of the laboratory of the Royal Institution, by a niece of Sir John Moore; and a manuscript book entitled "A Class Book for the Reception of Mental Exercises instituted July 1818," containing contributions by Faraday.

THE Council of the Society of Arts is prepared to award, under the terms of the Benjamin Shaw trust, a gold medal or a prize of 20*l.* "for any discovery, invention, or newly-devised method for obviating or materially diminishing any risk to life, limb or health incidental to any industrial occupation, and not previously capable of being so obviated or diminished by any known or practically available means." Intending competitors should send in descriptions of their inventions not later than May 1, 1902, to the secretary of the Society of Arts, Adelphi, London, W.C.

THE Royal College of Physicians of London has appointed Dr. D. Ferrier, F.R.S., as Harveian orator for this year, Dr. Cullingworth as Bradshaw lecturer, and Dr. H. T. Bulstrode as Milroy lecturer.

THE manuscript of a French translation of Viete's works has been presented to the Paris Academy of Sciences by the family of the late M. F. Ritter, who devoted many years of his life in translating the Latin text and adding explanatory notes. The documents also include a history of the great geometrician's life and times.

ON Saturday, February 15, Lord Rayleigh will begin a course of six lectures at the Royal Institution on "Some Electrical Developments." The Friday evening discourse on Friday, February 7, will be delivered by Prof. E. Ray Lankester, his subject being "The New Mammal from Central Africa and other Giraffe-like Animals."

THE London County Council has appointed Prof. A. C. Haddon, F.R.S., advising curator in connection with the Horniman Museum at Forest Hill. It will be remembered that this museum was presented by its founder, Mr. E. J. Horniman, M.P., to the Council last year. It contains a fine collection of anthropological, art and natural history objects.

THE sixty-third anniversary meeting of the Royal Agricultural Society will be held on Thursday, May 22. The Society's annual exhibition of live stock, implements, poultry and produce will be held at Carlisle in the week commencing Monday, July 7. An appeal has been issued by the Society for funds for the purchase and preparation of the site in the metropolis which has been selected for the future permanent showyard of the Society.

PROF. E. MILLOSEVICH has succeeded Prof. P. Tacchini as director of the Astronomical Observatory of the Roman College and of the astronomical museum connected with it. Prof. Tacchini has resigned his office of administrator in the Reale Accademia dei Lincei, and Prof. Volterra has been appointed as his successor. Prof. P. Villari having been unable to accept the office as president, an election to the presidential chair will be made early in June.

THE executive committee of the Jenner Society has resolved that, in view of the provisional character of the Vaccination Act of 1898, and as a preliminary to the further legislation which must be adopted next year in fulfilment of the promise made by the Government in regard to revaccination and of the termination of the experimental period for which the Act was passed, a comprehensive and careful inquiry should be made into the working of the administrative machinery by which vaccination is promoted as well as of the results of the Act itself.

AT the annual general meeting of the Royal Scottish Arboricultural Society, held in Edinburgh on Friday last, Lord Mansfield said he was authorised to state that it was Mr. Hanbury's intention to appoint a departmental committee to inquire into and report upon the present position and future prospects of forestry and the planting and management of woodlands in the United Kingdom, and to consider whether any further measures might be taken with advantage, either by the provision of further educational facilities or otherwise, for their promotion and encouragement. Mr. Munro-Ferguson, M.P., has been invited and has consented to act as chairman of the committee.

MR. S. HARBERT HAMILTON has started on a scientific exploring and collecting trip of several months' duration in the vicinity of Santiago, Cuba. Collections will be made in all branches of natural history, the bulk of which will go to the New York Botanical Gardens, the American Museum of Natural History and the Academy of Natural Sciences of Philadelphia. Specialists or institutions desiring material in any branches direct from the locality are invited to correspond with Mr. Hamilton at Santiago, Cuba.

THE meeting of the British Ornithologists' Club on March 19 is to be specially devoted to an exhibition of photographic slides, illustrating bird-life of all kinds, taken by members of the Club and their friends in various parts of the world. It is expected that a large number of very interesting light-pictures will be shown on this occasion.

FROM the *American Field* we learn that a young female specimen of that rare Arctic mammal, the musk-ox (*Ovibos moschatus*), reached Chicago alive at the beginning of January last. It is said to have been captured by hunters employed for the purpose by Captain H. H. Bodfish, of the steam-whaler *Beluga* (of San Francisco), near Cape Bathurst in the Arctic Ocean. A figure is given of this animal, which is stated to be the only living musk-ox ever brought alive to the United States. The only specimen of the musk-ox in England is that belonging to the Duke of Bedford at Woburn. There are, however, said to be also examples of this animal in the Zoological Gardens of Copenhagen and Berlin.

WE are glad to be able to record the formation of an Acetylene Association, which is similar in character to the associations which have existed for some time in several countries abroad. The object of the Association, as stated in the articles thereof, is "To promote the advancement of acetylene gas engineering and manufacture, and to facilitate the interchange of information amongst the members of the Association." An attempt was made in 1898 to found such an association, largely on the initiation of Sir David Salomons, but the trade did not then show sufficient general interest in the matter to make this possible. In reviewing this attempt a note of bitterness is sounded as to the opposition which every new industry started in this country has to encounter. Perhaps we may hope that the functions of the National Physical Laboratory will be wide enough in scope to make such repinings unnecessary, by giving new industries a helping hand in the future. The chairman of the Association is Mr. F. G. Worth, manager of the Acetylene Illuminating Company, who, as one of the prime movers in the formation of the Association, has devoted much time and care to bringing matters to a successful issue. The members of the council as at present constituted are nearly all members of well-known firms interested in acetylene, but several vacancies have yet to be filled up at the first annual general meeting, to be held on February 27. Subsequent to this, meetings will be arranged at which papers will be read and discussed. The official organ of the Association is, for the present, the *Journal of Acetylene Gas Lighting*, and the present secretary is Mr. Lacey Downes, of 11, Ironmonger Lane, Cheapside.

DURING the past week this country, in common with the greater part of western Europe, has been visited with inclement weather and very keen north-east winds. In Scotland the temperature in the screen has fallen 20° and more below the freezing point, the minimum reading during Friday night being 7° at Nairn. In the south the thermometer has not been much below the freezing point, but the north-east wind has been stronger than in the north, and this has greatly added to the sensation of cold. The barometer has risen above 31 inches in the north of Scotland, the reading at Aberdeen being 31·11 inches at 10 p.m. on Friday, which is as high as the very exceptional reading in our islands in January, 1896. Barometrical gradients have been very steep over the south of England and in France and Germany, which have given rise to fierce north-easterly gales in the Channel and over the southern portion of the North Sea. The gales have been unusually prolonged, continuing without interruption for about three days.

IN one of the important articles contained in vol. xxiii. of *Aus dem Archiv der Deutschen Seewarte*, Dr. Grossmann discusses the results of the maximum and minimum temperatures at Hamburg during the last quarter of a century (1876-1900). During this period the highest readings were 89°·6 in July 1883, and 89°·1 in May 1892. The lowest were −3°·6 in December 1876, and −1°·1 in January 1893. Temperatures of 86°·0 and upwards were recorded seventeen times between May and August, and 3°·0 and below also seventeen times between December and February. If we denote as summer days those on which the highest temperature reached or exceeded 77°, and as wintry days those on which the temperature remained below the freezing point, we find that the latter were twice as frequent as the former. The distribution shows that the so-called wintry days occurred as late as March and as early as November, and that the summer days occurred as early as May and as late as September. April and October were the most temperate months; the highest reading did not exceed 77°, and the lowest did not fall below the freezing point.

AN interesting paper by Herr Hofrath J. Hann appears in a January number (No. 1, 1902) of the *Transactions* of the section of mathematics and natural sciences of the Vienna Academy of Sciences, entitled "The Variations of Rainfall during long Periods of Time." Herr Hann discusses the monthly and yearly means of the values of the rainfall for the stations Padua (1725-1900), Klagenfurt (1813-1900) and Mailand (1764-1900), and finds that they all conform to a period of definite length. In the investigation he first of all obtains the extreme yearly sums of the rainfall expressed in per cent. of the total mean, and finds the following values for the past century (1801-1900):—

Driest year....	Padua 58	Klagenfurt 42	Mailand 62	per cent.
Wettest ,, ...	,, 152	,, 151	,, 152	,,

Using the earlier observations of Padua so far back as 1725, the extremes for this station became 56 per cent. and 181 per cent. Taking the frequency of similar yearly totals during the last hundred years, he groups the wet and dry years as shown in the following summary:—

Character	Very dry	Dry	About normal	Wet	Very wet	Extra-ordinarily wet
Per cent...	51-70	71-90	91-110	111-130	131-150	over 150
Number...	8	26	37	22	6	1

These figures show that the dry years predominate, 34 per cent. being dry and 29 per cent. wet, but the wet years exceed to a greater extent the mean yearly value of rainfall than the dry years. Herr Hann then determines the mean epochs of these wet and dry periods and finds that they satisfy a thirty-five-year period, with their maxima (wet) and minima (dry) in the following years:—

Wet..........	1738	1773	1808	1843	1878	(1913)
Dry..........	1753	1788	1823	1859	1893	(1928).

This period of thirty-five years and the above epochs are in complete harmony with the secular variation of rainfall indicated by Brückner in his "Klima-schwankungen," and agree with the long-period variation of sunspots recently shown to exist by Dr. Lockyer.

THE Report of the museum committee of the Bristol Museum for 1901 shows that many desirable improvements were effected by the curator, Mr. H. Bolton. The condition of the specimens has been greatly improved; in particular, the cases of birds have been thoroughly worked over, many of the birds being remounted. As the only trained official in the Museum is Mr. Bolton himself, though the Museum is a large one and belongs to the city, the fact that so much was done last year is a testimony to the zeal of the curator. Perhaps the most important work of the kind is that which has been effected upon the numerous and valuable Liassic fossil reptiles, which were in a very unsatisfactory condition. By arrangement with the authorities of the British Museum of Natural History, the worst of the specimens have been thoroughly repaired by one of their expert staff, and in this way they have been saved from further injury. Thanks to the committee of the Egypt Exploration Fund, the Museum possesses one of the most complete collections of Egyptian antiquities to be found in the provinces, and it has the advantage of being compact and consecutive in historical continuity rather than large and disconnected. The Museum is evidently appreciated, for the number of visitors in 1901 was 116,246, which is nearly twice as many as in 1898, when the present curator commenced his duties. The long and valuable list of donations also shows that interest is taken in the work of the Museum, but it is difficult to see how these gifts can be properly taken in hand, registered, classified and exhibited to the best advantage by the present very inadequate scientific staff. The latest donation is from Lady Smyth, who has presented to the Museum a large part of the

natural history collections of the late Sir Greville Smyth. Among the specimens are a fine egg of the Great Auk, an egg of the *Aepyornis maximus*, a collection of British and foreign birds' eggs and nests, a large collection of birds' skins, comprising a skin of the Apteryx, a collection of the Lepidoptera of India, Ceylon, South America and southern Europe, and also a very complete collection of British species, a collection of exotic Coleoptera, and a choice series of shells. The whole of these valuable natural history specimens are contained in a costly range of cabinets. Lady Smyth has also promised to present two specimen heads of the red deer bred in Ashton Park.

THE "Acker" fusion process for the electrolytic production of caustic alkali and chlorine is reported to be working successfully at Niagara Falls. The process depends upon the decomposition of molten salt with a carbon anode, and a kathode of molten lead. A lead-sodium alloy is formed at the kathode. The circulation and renewal of the molten kathode material is effected by means of high-pressure-steam and an injector. The lead-sodium alloy is carried into a separate vessel, where the steam decomposes the alloy with formation of sodium hydrate, hydrogen and lead. By careful regulation of the steam supply, the caustic alkali can be obtained as fused anhydrous NaOH, and the necessity for evaporation of the surplus water at a later stage is avoided. The hydrogen gas is collected and burnt, the heat being utilised for the preliminary heating of the rock salt used to feed the cell; while the molten lead flows back into the cell and functions again as kathode. The mechanical difficulties that have had to be surmounted in the transfer of this process from the laboratory to the works have been great, but, according to the *Electrician* of January 17, 3000 h.p. is now being utilised by this most interesting process at Niagara Falls, and anhydrous caustic soda is being produced, without any after boiling-down or evaporation. This latter is one of the chief features of the Acker process, and if the saving in fuel which results is not balanced by very heavy charges for cell maintenance and repairs, the process would appear to have a highly successful future before it.

THE *Bulletin international* of the Cracow Academy for November, 1901, contains an account, by M. L. Marchlewski, of the researches of the late Prof. Marcellus Nencki. Nencki was born in 1847 at Sieradz, Poland, and studied at Cracow, Jena and Berlin. He held office as assistant lecturer in pathological anatomy at Bern, and in 1878 was appointed professor of physiological chemistry. From 1891 till his death he was head of the chemical department of the Institute for Practical Medicine at St. Petersburg. He made many important advances in the study of physiological chemistry.

THE *Rendiconto* of the Naples Academy contains a short abstract of a paper by G. de Lorenzo, to be published in the *Atti* of the Academy, dealing with the superficial origin of volcanoes. Signor de Lorenzo seeks to prove, from a study of the volcanoes of southern Italy, that eruptive phenomena in general, and volcanic phenomena in particular, are intimately connected with mountain formation, and like the latter represent purely superficial effects on the earth, a view which is inconsistent with the hypothesis that they are due to an incandescent central fluid mass within. Signor de Lorenzo has illustrated his theory by pictures of Monte Nuovo, a hill of which the only illustration, even in recent treatises, has been that of Hamilton, dating from last century.

THE *Journal* of the Society of Arts contains a paper by Mr. Frank Gray on elliptographs. The various mechanical apparatus for drawing an ellipse are considered by Mr. Gray to depend on four methods, namely, the focal method, the trammel method, the mechanical method and the projective method. After reading the paper we are inclined to think that while the instruments described by Mr. Gray are highly ingenious, there is still room for someone to invent a really *simple* and portable instrument for drawing circles in perspective, an operation that is of constant occurrence in geometrical drawing. Many of the instruments described appear to be best suited to drawing large ellipses, whereas small ellipses are often required for diagrammatic illustrations. Moreover, a further desideratum is to be able to adjust easily an instrument to draw an ellipse of given dimensions, in particular one where two conjugate diameters, instead of the principal axes, are given. Among the instruments considered by Mr. Gray was Nasmyth's instrument now in the possession of the Board of Education. It is remarkable that so late as 1894 two Germans obtained a patent in Great Britain for a "trammel, pure and simple."

AN important paper on the electromagnetic properties of convection currents is published by Prof. A. Righi in the *Nuovo Cimento* (5, ii). It deals with the four fundamental principles according to which it is believed that (1) a moving charge generates a magnetic field, (2) changes in a magnetic field produce an electrostatic field, (3) a moving pole generates an electrostatic field, (4) changes in an electrostatic field produce a magnetic field. Experiments of Crémieu have thrown some doubt on the production of a magnetic field by convection of electrostatic charges, and even the existence of unclosed currents has been suggested. Prof. Righi gives a critical examination of Crémieu's experiments, as also of those of Rowland, Lodge, Wilson, Pender and others, and describes experiments in verification of the second of the four phenomena. The general conclusion is that Crémieu's experiments need not shake our faith in modern electrical theory, although it still appears desirable, if not necessary, that new and accurate researches should be undertaken for the purpose of confirming the above four phenomena individually as well as other phenomena depending on the same laws.

WE have received from the publisher (Mr. L. U. Gill) a copy of the seventh issue of that useful little work, "The Naturalists' Directory." The new volume appears to be much better than its predecessors.

THE *Proceedings* of the Indiana Academy of Sciences for 1900 contains a list of the papers read at the sixteenth annual meeting, many of these being printed only in brief abstract. The president's address is illustrated with some excellent reproductions of photographs of microscopic objects.

IN the Report for the year 1901, the Northumberland Sea Fisheries Committee gives a most satisfactory account of the food-fishes of the district, based on the experimental trawling excursions carried on during the past ten years. The results for the whole four stations where the experiments have been conducted are as follows:—"Turbot have remained steady; brill seem to be improving in numbers; soles are getting less numerous every year, practically speaking; plaice have slightly improved, and dabs have greatly improved in numbers; flounders also presented a slight increase." A total increase of about 20 per cent. in the number of food-fishes frequenting the bays is estimated to have taken place during the last five years, and the Committee therefore feels justified in saying that the locality is slowly recovering from the effects of the excessive in-shore trawling carried on just previous to the commencement of the experiments.

THE *Scientific American* for January 18 issues a supplement (No. 1359) devoted to a comparison of the Panama and Nicaragua canal routes. The supplement contains an exhaustive

article on each canal and a digest of the report of the Canal Commission; it is illustrated by about forty views and diagrams. In the ordinary number is a short summary of the matter to be found in the supplement, and a full-page illustration showing the two canals in plan.

The *National Geographic Magazine* publishes, as a supplement to its January number, the official map of the Philippines prepared by the United States Signal Officer under the direction of General Greely. The map is in two sheets, on a scale of 1 : 900,000, and shows telegraph lines and cables, telephone lines, open ports, lighthouses and post offices. The spelling of names is that adopted by the U.S. Board on Geographic Names. A remarkable feature is the large amount of country, in the island of Mindoro especially, which remains blank on the map, awaiting exploration.

Dr. Martin Knudsen contributes a paper on the oceanography of the straits connecting the Baltic and the North Sea to the January number of *La Geographie*, in which he gives a short account of the work of the Danish Commission during the past ten years, and brings it into relation with the researches of Pettersson and Ekman. The seasonal variations of the inflowing and outflowing streams are fully described; a section is devoted to the discussion of the distribution of temperature in the Kattegat and the western Baltic, and another to the relative volumes of the Baltic current and the inflowing current of salter water, as deduced from the salinity observations. With regard to the Baltic current, the remarkable result has been arrived at that its volume is four to six times greater than can be accounted for by the supply of fresh water by rainfall in the Baltic basin alone, and that this cause is largely assisted by the winds and by the variations of atmospheric pressure on the surface of the sea itself.

A catalogue of the types and figured fossils in the geological department of the American Museum of Natural History, New York, has been published as the eleventh volume of the *Bulletin* of the Museum. It is needless to say that such catalogues are of great service to palæontologists. The Museum contains the James Hall collection, which includes a large number of type and figured Palæozoic fossils; it also contains other interesting and important collections from strata of various ages in North America, including the fruits and seeds from the Eocene beds of Brandon, Vermont, described by Lesquereux, Pliocene and post-Pliocene fossils from South Carolina, &c. There are also Cretaceous fossils from Syria, Jamaica, &c. The term "type" is employed to embrace not only the specimens actually used by an author in the original description of a species, but those specimens which have been used by the same author in the further elucidation of the species in subsequent publications. This valuable record, for which we are indebted to Mr. R. P. Whitfield, the curator, and his associate, Mr. E. O. Hovey, enumerates 8345 type and figured specimens, representing 2721 species and 190 varieties.

Among the forthcoming publications of the Clarendon Press is an authorised translation of Schimper's "Geography of Plants," by Profs. Percy Groom and W. R. Fisher.

The third volume of Lord Rayleigh's collected papers, containing papers published from 1887 to 1892, has been published by the Cambridge University Press. The next volume will bring the collection down to nearly the present time, and will, it is hoped, be ready in about a year. The complete work will then be reviewed in these columns.

Messrs. F. Vieweg and Son, Brunswick, announce that the preparation of a biography of the late Prof. Helmholtz has been undertaken by Prof. Leo Königsberger, and will be published by them. The work will contain the letters which passed between Helmholtz and his father, and correspondence with personal and scientific friends. Many men of science will look forward with pleasure to the publication of the biography of one who contributed so much to the progress of natural knowledge.

Mr. H. K. Lewis, of Gower Street, W.C., is extending his circulating library of medical and scientific books. New books and new editions are added to the library immediately on publication, so that it is possible for students with limited incomes to keep themselves in close touch with all important additions to scientific literature. The library provides a useful means for obtaining standard works for study, or for examination with a view to purchase. The lists of scientific books and periodicals circulated by Mr. Lewis are worth attention.

In the Siebenbürgen salt district (Transylvania) are some warm salt lakes which have recently been examined by A. V. Kalecsinsky, chemist to the Hungarian Geological Survey. They are remarkable for having a layer of warm or even hot salt water between two colder bodies of water, the surface being fresh water while the rest is highly saline. In the Medoc See, for example, when the surface was in summer at a temperature of 21° C., at a depth of 1·3 metres the temperature was 56° C. and the specific gravity 1·17, thence declining gradually to the bottom to 19° C. with a specific gravity of 1·19, corresponding to 25 per cent. of salt in solution. The warm layer in summer has been found to reach 70° to 71° C., but during winter months it cools until the minimum in May is only 26° C. The author concludes that the lakes are not fed by hot springs nor warmed by chemical agency, but derive their heat from the sun. As the specific heat of brine is below that of water, the saline water is more readily warmed, and the fresh surface water prevents any rapid loss of heat by radiation. Some future useful application may, he thinks, be made of these natural heat-accumulators.

The additions to the Zoological Society's Gardens during the past week include two Vulpine Phalangers (*Trichosurus vulpecula*), two Laughing Kingfishers (*Dacelo gigantea*) from Australia, a Weka Rail (*Ocydromus australis*) from New Zealand, presented by H.R.H. the Prince of Wales, K.G.; a Malayan Paradoxure (*Paradoxurus hemaphroditus*) from Burmah, presented by Capt. Burnett; a Red-bellied Spider Monkey (*Ateles rufiventris*) from Colombia, a Long-haired Spider Monkey (*Ateles vellerosus*) from Central America, a Bungoma River Turtle (*Emyda granosa*), seven Roofed Terrapins (*Kachuga tectum*), five Hamilton's Terrapins (*Damonia hamiltoni*) from India, two Bicheno's Finches (*Estrelda bichenovii*) from Australia, deposited; a Sykes's Monkey (*Cercopithecus albigularis*) from East Africa, purchased; three Red River Hogs (*Potamochaerus penicillatus*) born in the Gardens.

OUR ASTRONOMICAL COLUMN.

Early Observations of Algol Stars.—In the *Harvard College Observatory Circular*, No. 64, Prof. E. C. Pickering furnishes particulars of additional observations of recently discovered variables, which have been obtained from examination of the photographs taken with the 8-inch Draper telescope.

78 (1901) Cygni.—R.A. = 20h. 18m. 4s.·0; Decl. = +42° 46′·4 (1855).

This star was announced as variable by Mr. Williams. On referring to the Harvard collection the star has been found on 177 plates, the first being on 1885 September 19 ten of the photographs showing the star to be fainter than the normal brightness. Determinations with the 12-inch meridian photometer give the maximum magnitude as 10·47, and taking this value, a light curve has been determined from observations with the 15-inch equatorial. The magnitude appears to decrease to about 13·05 at minimum. With an adopted period of 3d. 10h. 49m. 12s. a table of residuals is formed from the old and new measures, and more accurate results will probably

be obtained when the photographic light curve is better known, and also by correcting for aberration.

93 (1901) Sagittæ.—R.A. = 19h. 14m. 26s.; Decl. = $+19°$ $25'·4$ (1900).

The variability of this star was announced by Dr. Schwab, and subsequent inspection of the Harvard plates showed that there were 155 records of nearly normal brightness, the magnitude at this stage being 6·50, and 13 where the star was near minimum. A photograph obtained on 1895 August 22 shows a sudden change during the exposure from 9th to 8th magnitude. The range in light appears to be greater than that of any other Algol star. The suggested period of seventeen days does not appear to satisfy the observations, and observers in other situations are asked to forward any determinations as soon as possible.

UNITED STATES NAVAL OBSERVATORY REPORT.—The report of work accomplished at this observatory during the year ending June 30, 1901, has recently been distributed, and is here summarised.

26-inch Equatorial.—This instrument has been in charge of Prof. See, who has been engaged in determinations of the diameters of the planets and satellites of the solar system, observations of Eros for parallax, double star observations, &c. These, so far as reduced, have been published from time to time in the *Astronomische Nachrichten.*

12-inch Equatorial.—During the greater part of the year this has been dismounted for repairs. Since its readjustment it has been used for the observation of zone stars, double stars, &c., and also for the entertainment of visitors to the observatory, 765 admission cards having been issued during the year.

9-inch Transit Circle.—The regular sun, moon and planet work has been continued, and in addition a revision of the Astronomische Gesellschaft zones and the zone of zodiacal stars undertaken for the Paris Astronomical Conference of 1896. The instrument is in need of thorough repair, as an examination of the pivots reveals considerable inequalities, and the present method of oblique illumination is to be replaced by an axial arrangement.

6-inch Transit Circle.—Observations have been continued on comparison stars for planets, special stars for Eros reductions, and determinations of personal equation. A serious difficulty, however, has been the persistence of the large diurnal change of azimuth with temperature. Numerous experiments have been made, but the error is only partially remedied.

Clock Vault.—A considerable amount of time has been spent in an attempt to bring the timekeepers under more constant conditions. A vault eight feet square and seven feet high has been made in the basement of the observer's room near the 6-inch transit circle. In this a 9-inch brick wall encloses a wooden hut, with an intervening air space of one foot containing hot water pipes. The roof is covered over with boards enclosing a 6-inch layer of asbestos wool. The room is entered by triple doors, and it is hoped that by these precautions constant temperature conditions will be attained. The whole is on the summit of a hill to avoid drainage difficulties.

Prime Vertical Transit and 5-inch Altazimuth.—These instruments have been used in conjunction for the determination of latitude variation, the two distinct types of observation constituting a valuable check on the accuracy of results obtained.

40-foot Photoheliograph.—During the year photographs of the sun were obtained on 116 days. Of these, sunspots were recorded on 24 days. The photographs show many faculæ and fine detail in the granulation of the solar surface.

Nautical Almanac.—This is now under the direction of Prof. W. S. Harshman. Special effort is to be made to ensure the publication three years in advance. Investigations are being made to provide tables for Jupiter's satellites and the inner satellite of Uranus, and a new catalogue of zodiacal stars for computing occultations will be used in the preparation of the volume for 1905.

For a considerable time an important section of the staff was absent on the eclipse expedition to Sumatra. Although most of the parties were unfortunate in having bad weather, the observers at Fort de Kock obtained excellent photographs of the phenomenon.

Meteorological observations have been continued as in former years, but all the magnetic determinations have been discontinued owing to the interference of currents from the various electric systems in the neighbourhood.

THE DISCOVERY OF THE FUTURE.[1]

IT will lead into my subject most conveniently to contrast and separate two divergent types of mind, types which are to be distinguished chiefly by their attitude towards time and more particularly by the relative importance they attach and the relative amount of thought they give to the future of things.

The first of these two types of mind, and it is, I think, the predominant type, the type of the majority of living people, is that which seems scarcely to think of the future at all, which regards it as a sort of black non-existence upon which the advancing present will presently write events. The second type, which is, I think, a more modern and much less abundant type of mind, thinks constantly and by preference of things to come, and of present things mainly in relation to the results that must arise from them. The former type of mind, when one gets it in its purity, is retrospective in habit, and it interprets the things of the present, and gives value to this and denies it to that, entirely with relation to the past. The latter type of mind is constructive in habit, it interprets the things of the present and gives value to this or that, entirely in relation to things designed or foreseen. While from that former point of view our life is simply to reap the consequences of the past, from this our life is to prepare the future. The former type one might speak of as the legal or submissive type of mind, because the business, the practice and the training of a lawyer dispose him towards it; he of all men must most constantly refer to the law made, the right established, the precedent set, and most consistently ignore or condemn the thing that is only seeking to establish itself. The latter type of mind I might for contrast call the legislative, creative, organising or masterful type, because it is perpetually attacking and altering the established order of things, perpetually falling away from respect for what the past has given us. It sees the world as one great workshop, and the present is no more than material for the future, for the thing that is yet destined to be. It is in the active mood of thought while the former is in the passive; it is the mind of youth, it is the mind more manifest among the western nations while the former is the mind of age, the mind of the oriental.

Things have been, says the legal mind, and so we are here. And the creative mind says, we are here, because things have yet to be.

Now I do not wish to suggest that the great mass of people belong to either of these two types. Indeed, I speak of them as two distinct and distinguishable types mainly for convenience and in order to accentuate their distinction. There are probably very few people who brood constantly upon the past without any thought of the future at all, and there are probably scarcely any who live and think consistently in relation to the future. The great mass of people occupy an intermediate position between these extremes, they pass daily and hourly from the passive mood to the active, they see this thing in relation to its associations and that thing in relation to its consequences, and they do not even suspect that they are using two distinct methods in their minds.

But for all that they are distinct methods, the method of reference to the past and the method of reference to the future, and their mingling in many of our minds no more abolishes their difference than the existence of piebald horses proves that white is black.

I believe that it is not sufficiently recognised just how different in their consequences these two methods are, and just where their difference and where the failure to appreciate their difference takes one. This present time is a period of quite extraordinary uncertainty and indecision upon endless questions—moral questions, æsthetic questions, religious and political questions—upon which we should all of us be happier to feel assured and settled, and a very large amount of this floating uncertainty about these important matters is due to the fact that with most of us these two insufficiently distinguished ways of looking at things are not only present together, but in actual conflict in our minds, in unsuspected conflict; we pass from one to the other heedlessly without any clear recognition of the fundamental difference in conclusions that exists between the two, and we do this with disastrous results to our confidence and to our consistency in dealing with all sorts of things.

But before pointing out how divergent these two types or habits of mind really are, it is necessary to meet a possible objection to what has been said. I may put that objection in this

[1] A discourse delivered at the Royal Institution on Friday, January 24, by Mr. H. G. Wells.

form—Is not this distinction between a type of mind that thinks of the past and of a type of mind that thinks of the future a sort of hair-splitting almost like distinguishing between people who have left hands and people who have right? Everybody believes that the present is entirely determined by the past, you say; but, then, everybody believes *also* that the present determines the future. Are we simply separating and contrasting two sides of everybody's opinion? To which one replies that we are not discussing what we know and believe about the relations of past, present and future, or of the relation of cause and effect to each other in time. We all know the present depends for its causes on the past and that the future depends for its causes upon the present. But this discussion concerns *the way in which we approach things* upon this common ground of knowledge and belief. We may all know there is an east and a west, but if some of us always approach and look at things from the west, if some of us always approach and look at things from the east, and if others again wander about with a pretty disregard of direction, looking at things as chance determines, some of us will get to a westward conclusion of this journey, and some of us will get to an eastward conclusion, and some of us will get to no definite conclusion at all about all sorts of important matters. And yet those who are travelling east, and those who are travelling west, and those who are wandering haphazard, may be all upon the same ground of belief and statement and amidst the same assembly of proven facts. Precisely the same thing will happen if you always approach things from the point of view of their causes, or if you approach them always with a view to their probable effects. And in several very important groups of human affairs it is possible to show quite clearly just how widely apart the two methods, pursued each in its purity, take those who follow them.

I suppose that three hundred years ago all people who thought at all about moral questions, about questions of right and wrong, deduced their rules of conduct absolutely and unreservedly from the past, from some dogmatic injunction, some finally settled decree. The great mass of people do so to-day. It is written, they say. Thou shalt not steal, for example—that is the sole, complete and sufficient reason why you should not steal, and even to-day there is a strong aversion to admit that there is any relation between the actual consequences of acts and the imperatives of right and wrong. Our lives are to reap the fruits of determinate things, and it is still a fundamental presumption of the established morality that one must do right though the heavens fall. But there are people coming into this world who would refuse to call it right if it brought the heavens about our heads, however authoritative its sources and sanctions, and this new disposition is, I believe, a growing one. I suppose in all ages people in a timid, hesitating, guilty way have tempered the austerity of a dogmatic moral code by small infractions to secure obviously kindly ends, but it was, I am told, the Jesuits who first deliberately sought to qualify the moral interpretation of acts by a consideration of their results. To-day there are few people who have not more or less clearly discovered the future as a more or less important factor in moral considerations. To-day there is a certain small proportion of people who frankly regard morality as a means to an end, as an overriding of immediate and personal considerations out of regard to something to be attained in the future, and who break away altogether from the idea of a code dogmatically established for ever. Most of us are not so definite as that, but most of us are deeply tinged with the spirit of compromise between the past and the future; we profess an unbounded allegiance to the prescriptions of the past, and we practise a general observance of its injunctions, but we qualify to a vague, variable extent with considerations of expediency. We hold, for example, that we must respect our promises. But suppose we find unexpectedly that for one of us to keep a promise, which has been sealed and sworn in the most sacred fashion, must lead to the great suffering of some other human being, must lead, in fact, to practical evil? Would a man do right or wrong if he broke such a promise? The practical decision most modern people would make would be to break the promise. Most would say that they did evil to avoid a greater evil. But suppose it was not such *very* great suffering we were going to inflict, but only some suffering? And suppose it was a rather important promise? With most of us it would then come to be a matter of weighing the promise, the thing of the past, against this unexpected bad consequence, the thing of the future. And the smaller the overplus of evil consequences, the more most of us would vacillate. But neither of the two types of mind we are contrasting would vacillate at all. The legal type of mind would obey the past unhesitatingly, the creative would unhesitatingly sacrifice it to the future. The legal mind would say, "they who break the law at any point, break it altogether," while the creative mind would say, "let the dead past bury its dead." It is convenient to take my illustration from the sphere of promises, but it is in the realm of sexual morality that the two methods are most acutely in conflict.

And I would like to suggest that until you have definitely determined either to obey the real or imaginary imperatives of the past, or to set yourself towards the demands of some ideal of the future, until you have made up your mind to adhere to one or other of these two types of mental action in these matters, you are not even within hope of a sustained consistency in the thought that underlies your acts, that in every issue of principle that comes upon you, you will be entirely at the mercy of the intellectual mood that happens to be ascendant at that particular moment in your mind.

In the sphere of public affairs also, these two ways of looking at things work out into equally divergent and incompatible consequences. The legal mind insists upon treaties, constitutions, legitimacies and charters; the legislative incessantly assails these. Whenever some period of stress sets in, some great conflict between institutions and the forces in things, there comes a sorting between these two types of mind. The legal mind becomes glorified and transfigured in the form of hopeless loyalty, the creative mind inspires revolutions and reconstructions. And particularly is this difference of attitude accentuated in the disputes that arise out of wars. In most modern wars there is no doubt quite traceable on one side or the other a distinct creative idea, a distinct regard for some future consequence. But the main dispute even in most modern wars and the sole dispute in most mediæval wars will be found to be a reference, not to the future, but to the past; to turn upon a question of fact and right. The wars of Plantagenet and Lancastrian England with France, for example, were based entirely upon a dummy claim, supported by obscure legal arguments, upon the crown of France. And the arguments that centre about the present war in South Africa ignore any ideal of a great united South African State almost entirely, and quibble this way and that about who began the fighting and what was or was not written in some obscure revision of a treaty a score of years ago. Yet beneath the legal issues, the broad creative idea has been very apparent in the public mind during this war. It will be found more or less definitely formulated beneath almost all the great wars of the past century, and a comparison of the wars of the nineteenth century with the wars of the middle ages will show, I think, that in this field also there has been a discovery of the future, an increasing disposition to shift the reference and values from things accomplished to things to come.

Yet though foresight creeps into our politics and a reference to consequence into our morality, it is still the past that dominates our lives. But why? Why are we so bound to it? It is into the future we go, to-morrow is the eventful thing for us. There lies all that remains to be felt by us and our children and all those that are dear to us. Yet we marshal and order men into classes entirely with regard to the past, we draw shame and honour out of the past; against the rights of property, the vested interests, the agreements and establishments of the past, the future has no rights. Literature is for the most part history or history at one remove, and what is culture but a mould of interpretation into which new things are thrust, a collection of standards, a sort of bed of King Og, to which all new expressions must be lopped or stretched? Our conveniences, like our thoughts, are all retrospective. We travel on roads so narrow that they suffocate our traffic; we live in uncomfortable, inconvenient, life-wasting houses out of a love of familiar shapes and familiar customs and a dread of strangeness, all our public affairs are cramped by local boundaries impossibly restricted and small. Our clothing, our habits of speech, our spelling, our weights and measures, our coinage, our religious and political theories, all witness to the binding power of the past upon our minds. Yet—we do not serve the past as the Chinese have done. There are degrees. We do not worship our ancestors or prescribe a rigid local costume; we venture to enlarge our stock of knowledge, and we qualify the classics with occasional adventures into original thought. Compared with the Chinese we are distinctly aware

of the future. But compared with what we might be, the past is all our world.

The reason why the retrospective habit, the legal habit, is so dominant and always has been so predominant, is of course a perfectly obvious one. We follow the fundamental human principle and take what we can get. All people believe the past is certain, defined and knowable, and only a few people believe that it is possible to know anything about the future. Man has acquired the habit of going to the past because it was the line of least resistance for his mind. While a certain variable portion of the past is serviceable matter for knowledge in the case of everyone, the future is, to a mind without an imagination trained in scientific habits of thought, non-existent. All our minds are made of memories. In our memories each of us has something that without any special training whatever will go back into the past and grip firmly and convincingly all sorts of workable facts, sometimes more convincingly than firmly. But the imagination, unless it is strengthened by a very sound training in the laws of causation, wanders like a lost child in the blackness of things to come and returns—empty.

Many people believe, therefore, that there can be no sort of certainty about the future. You can know no more about the future, I was recently assured by a friend, than you can know which way a kitten will jump next. And to all who hold that view, who regard the future as a perpetual source of convulsive surprises, as an impenetrable, incurable, perpetual blackness, it is right and reasonable to derive such values as it is necessary to attach to things from the events that have certainly happened with regard to them. It is our ignorance of the future and our persuasion that that ignorance is absolutely incurable that alone gives the past its enormous predominance in our thoughts. But through the ages, the long unbroken succession of fortune tellers—and they flourish still—witnesses to the perpetually smouldering feeling that after all there *may* be a better sort of knowledge—a more serviceable sort of knowledge than that we now possess.

On the whole there is something sympathetic for the dupe of the fortune teller in the spirit of modern science; it is one of the persuasions that come into one's mind, as one assimilates the broad conceptions of science, that the adequacy of causation is universal; that in absolute fact, if not in that little bubble of relative fact, which constitutes the individual life, in absolute fact the future is just as fixed and determinate, just as settled and inevitable, just as possible a matter of knowledge as the past. Our personal memory gives us an impression of the superior reality and trustworthiness of things in the past, as of things that have finally committed themselves and said their say, but the more clearly we master the leading conceptions of science the better we understand that this impression is one of the results of the peculiar conditions of our lives and not an absolute truth. The man of science comes to believe at last that the events of the year A.D. 4000 are as fixed, settled and unchangeable as the events of the year 1600. Only about the latter he has some material for belief and about the former practically none.

And the question arises how far this absolute ignorance of the future is a fixed and necessary condition of human life, and how far some application of intellectual methods may not attenuate even if it does not absolutely set aside the veil between ourselves and things to come. And I am venturing to suggest to you that, along certain lines and with certain qualifications and limitations, a working knowledge of things in the future is a possible and practicable thing.

And in order to support this suggestion I would call your attention to certain facts about our knowledge of the past, and more particularly I would insist upon this, that about the past our range of absolute certainty is very limited indeed. About the past I would suggest we are inclined to overestimate our certainty, just as I think we are inclined to underestimate the certainties of the future. And such a knowledge of the past as we have is not all of the same sort, or derived from the same sources.

Let us consider just what an educated man of to-day knows of the past. First of all he has the reallest of all knowledge, the knowledge of his own personal experiences, his memory. Uneducated people believe their memories absolutely, and most educated people believe them with a few reservations. Some of us take up a critical attitude even towards our own memories; we know that they not only sometimes drop things out, but that sometimes a sort of dreaming or a strong suggestion will put things in. But for all that memory remains vivid and real as no other knowledge can be, and to have seen and heard and felt is to be nearest to absolute conviction. Yet our memory of direct impressions is only the smallest part of what we know. Outside that bright area comes knowledge of a different order, the knowledge brought to us by other people. Outside our immediate personal memory there comes this wider area of facts, or quasi-facts, told us by more or less trustworthy people, told us by word of mouth or by the written word of living and of dead writers. This is the past of report, rumour, tradition and history, the second sort of knowledge of the past. The nearer knowledge of this sort is abundant and clear and detailed, remoter it becomes vaguer, still more remotely in time and space it dies down to brief, imperfect inscriptions and enigmatical traditions, and at last dies away, so far as the records and traditions of humanity go, into a doubt and darkness as black, just as black, as futurity. And now let me remind you that this second zone of knowledge outside the bright area of what we have felt and witnessed and handled for ourselves, this zone of hearsay and history and tradition completed the whole knowledge of the past that was accessible to Shakespeare, for example. To these limits man's knowledge of the past was absolutely confined save for some inklings and guesses, save for some small, almost negligible beginnings, until the nineteenth century began. Beside the correct knowledge in this scheme of hearsay and history a man had a certain amount of legend and error that rounded off the picture in a very satisfying and misleading way, according to Bishop Ussher, just exactly 4004 years B.C. And that was man's universal history—that was his all, until the scientific epoch began. And beyond those limits—? Well, I suppose the educated man of the sixteenth century was as certain of the non-existence of anything before the creation of the world as he was, and as most of us are still, of the practical non-existence of the future, or at any rate he was as satisfied of the impossibility of knowledge in the one direction as in the other.

But modern science, that is to say, the relentless systematic criticism of phenomena, has in the past hundred years absolutely destroyed the conception of a finitely distant beginning of things; has abolished such limits to the past as a dated creation set, and added an enormous vista to that limited sixteenth century outlook. And what I would insist upon is that this further knowledge is a new kind of knowledge, obtained in a new kind of way. We know to-day, quite as confidently and in many respects more intimately than we know Sargon, or Zenobia, or Caractacus, the form and the habits of creatures that no living being has ever met, that no human eye has ever regarded, and the character of scenery that no man has ever seen or can ever possibly see; we picture to ourselves the labyrinthodon raising its clumsy head above the waters of the Carboniferous swamps in which he lived, and we figure the pterodactyls, those great bird lizards, flapping their way athwart the forests of the Mesozoic age with exactly the same certainty as that with which we picture the rhinoceros or the vulture. I doubt no more about the facts in this further picture than I do about those in the nearest. I believe in the megatherium which I have never seen as confidently as I believe in the hippopotamus that has engulfed buns from my hand. A vast amount of detail in that further picture is now fixed and finite for all time. And a countless number of investigators are persistently and confidently enlarging, amplifying, correcting and pushing further and further back the boundaries of this greater past, this pre-human past that the scientific criticism of existing phenomena has discovered and restored and brought for the first time into the world of human thought. We have become possessed of a new and once unsuspected history of the world—of which all the history that was known, for example, to Doctor Johnson, is only the brief concluding chapter. And even that concluding chapter has been greatly enlarged and corrected by the exploring archæologist working strictly upon the lines of the new method, that is to say, the comparison and criticism of suggestive facts.

I want particularly to insist upon this, that all this outer past—this non-historical past—is the product of a new and keener habit of inquiry, and no sort of revelation. It is simply due to a new and more critical way of looking at things. Our knowledge of the geological past, clear and definite as it has become, is of a different and lower order than the knowledge of our memory, and yet of a quite practicable and trustworthy order, a knowledge good enough to go upon. And if one were to

speak of the private memory as the personal past, as the next wider area of knowledge as the traditional or historical past, then one might call all that great and inspiring background of remoter geological time, the inductive past.

And this great discovery of the inductive past was got by the discussion and rediscussion and effective criticism of a number of existing facts, odd-shaped lumps of stone, streaks and bandings in quarries and cliffs, anatomical and developmental details that had always been about in the world, that had been lying at the feet of mankind so long as mankind had existed, but that no one had ever dreamt before could supply any information at all, much more reveal such astounding and enlightening vistas. Looked at in a new way they became sources of dazzling and penetrating light; the remoter past lit up and became a picture. Considered as effects, compared and criticised, they yielded a clairvoyant vision of the history of interminable years.

And now—if it has been possible for men by picking out a number of suggestive and significant looking things in the present, by comparing them, criticising them, and discussing them, with a perpetual insistence upon *why*? without any guiding tradition, and indeed in the teeth of established beliefs, to construct this amazing searchlight of inference into the remoter past—is it really, after all, such an extravagant and hopeless thing to suggest that, by seeking for operating causes instead of for fossils and by criticising them as persistently and thoroughly as the geological record has been criticised, it may be possible to throw a searchlight of inference forward instead of backward and to attain to a knowledge of coming things as clear, as universally convincing and infinitely more important to mankind than the clear vision of the past that geology has opened to us during the nineteenth century?

Let us grant that anything to correspond with the memory, anything having the same relation to the future that memory has to the past, is out of the question. We cannot imagine, of course, that we can ever know any personal future to correspond with our personal past, or any traditional future to correspond with our traditional past. But the possibility of an inductive future to correspond with that great inductive past of geology and archæology is an altogether different thing.

I must confess that I believe quite firmly that an inductive knowledge of a great number of things in the future is becoming a human possibility. I believe that the time is drawing near when it will be possible to suggest a systematic exploration of the future. And you must not judge the practicability of this enterprise by the failures of the past. So far nothing has been attempted, so far no first-class mind has ever focussed itself upon these issues. But suppose the laws of social and political development, for example, were given as many brains, were given as much attention, criticism and discussion as we have given to the laws of chemical combination during the last fifty years—what might we not expect?

To the popular mind of to-day there is something very difficult in such a suggestion, soberly made. But here, in this Institution which has watched for a whole century over the splendid adolescence of science, and where the spirit of science is surely understood, you will know that as a matter of fact prophecy has always been inseparably associated with the idea of scientific research. The popular idea of scientific investigation is a vehement, aimless collection of little facts, collected as the bower bird collects shells and pebbles, in methodical little rows, and out of this process, in some manner unknown to the popular mind, certain conjuring tricks—the celebrated wonders of science—in a sort of accidental way emerge. The popular conception of all discovery is accident. But you will know that the essential thing in the scientific process is not the collection of facts, but the analysis of facts; facts are the raw material and not the substance of science; it is analysis that has given us all ordered knowledge, and you know that the aim and the test and the justification of the scientific process is *not* a marketable conjuring trick, but prophecy. Until a scientific theory yields confident forecasts you know it is unsound and tentative; it is mere theorising, as evanescent as art talk or the phantoms politicians talk about. The splendid body of gravitational astronomy, for example, establishes itself upon the certain forecast of stellar movements, and you would absolutely refuse to believe its amazing assertions if it were not for these same unerring forecasts. The whole body of medical science aims, and claims the ability, to diagnose. Meteorology constantly and persistently aims at prophecy, and it will never stand in a place of honour until it can certainly foretell. The chemist forecasts elements before he meets them—it is very properly his boast—and the splendid manner in which the mind of Clerk Maxwell reached in front of all experiment and foretold those things that Marconi has materialised is familiar to us all.

And if I am right in saying that science aims at prophecy, and if the specialist in each science is in fact doing his best *now* to prophesy within the limits of his field, what is there to stand in the way of our building up this growing body of forecast into an ordered picture of the future that will be just as certain, just as strictly science, and perhaps just as detailed as the picture that has been built up within the last hundred years to make the geological past? Well, so far and until we bring the prophecy down to the affairs of man and his children, it is just as possible to carry induction forward as back; it is just as simple and sure to work out the changing orbit of the earth in the future until the tidal drag hauls one unchanging face at last towards the sun as it is to work back to its blazing and molten past. Until man comes in, the inductive future is as real and convincing as the inductive past. But inorganic forces are the smaller part and the minor interest in this concern. Directly man becomes a factor the nature of the problem changes, and our whole present interest centres on the question whether man is, indeed, individually and collectively incalculable, a new element which entirely alters the nature of our inquiry and stamps it at once as vain and hopeless, or whether his presence complicates, but does not alter, the essential nature of the induction. How far may we hope to get trustworthy inductions about the future of man?

Well, I think, on the whole, we are inclined to underrate our chance of certainties in the future just as I think we are inclined to be too credulous about the historical past. The vividness of our personal memories, which are the very essence of reality to us, throws a glamour of conviction over tradition and past inductions. But the personal future must in the very nature of things be hidden from us so long as time endures, and this black ignorance at our very feet, this black shadow that corresponds to the brightness of our memories behind us, throws a glamour of uncertainty and unreality over all the future. We are continually surprising ourselves by our own will or want of will; the individualities about us are continually producing the unexpected, and it is very natural to reason that as we can never be precisely sure before the time comes what *we* are going to do and feel, and if we can never count with absolute certainty upon the acts and happenings even of our most intimate friends, how much the more impossible is it to anticipate the behaviour in any direction of states and communities?

In reply to which I would advance the suggestion that an increase in the number of human beings considered may positively simplify the case instead of complicating it, that as the individuals increase in number they begin to average out. Let me illustrate this point by a comparison. Angular pit sand has grains of the most varied shapes. Examined microscopically you will find all sorts of angles and outlines and variations. Before you look, you can say of no particular grain what its outline will be. And if you shoot a load of such sand from a cart you cannot foretell with any certainty where any particular grain will be in the heap that you make. But you can tell, you can tell pretty definitely, the form of the heap as a whole. And further, if you pass that sand through a series of shoots, and finally drop it some distance to the ground, you will be able to foretell that grains of a certain sort of form and size will for the most part be found in one part of the heap, and grains of another sort of form and size will be found in another part of the heap. In such a case, you see, the thing as a whole may be simpler than its component parts, and this I submit is also the case in many human affairs. So that because the individual future eludes us completely, that is no reason why we should not aspire to, and discover and use, safe and serviceable generalisations upon countless important issues in the human destiny.

But there is a very grave and important-looking difference between a load of sand and a multitude of human beings, and this I must face and examine. Our thoughts and wills and emotions are contagious. An exceptional sort of sand grain, a sand grain that was exceptionally big and heavy, for example, exerts no influence worth considering upon any other of the sand grains in the load. They will fall and roll and heap themselves just the same, whether that exceptional grain is with them or not. But an exceptional man comes into the world, a Cæsar or a Napoleon or a Peter the Hermit, and he appears to persuade

and convince and compel and take entire possession of the sand heap—I mean the community—and to twist and alter its destinies to an almost unlimited extent. And if this is indeed the case, it reduces our project of an inductive knowledge of the future to very small limits. To hope to foretell the birth and coming of men of exceptional force and genius is to hope incredibly, and if, indeed, such exceptional men do do as much as they seem to do in warping the path of humanity, our utmost prophetic limit in human affairs is a conditional sort of prophecy. *If* people do so and so, we can say, then such and such results will follow, and we must admit that that is our limit.

But everybody does not believe in the importance of the leading man. There are those who will say that the whole world is different by reason of Napoleon. But there are also those who will say the whole world of to-day would be very much as it is now if Napoleon had never been born. There are those who believe entirely in the individual man and those who believe entirely in the forces behind the individual man, and for my own part I must confess myself a rather extreme case of the latter kind. I must confess I believe that if by some juggling with space and time Julius Cæsar, Napoleon, Edward IV., William the Conqueror, Lord Rosebery and Robert Burns had all been changed at birth, it would not have produced any serious dislocation of the course of destiny. I believe that these great men of ours are no more than images and symbols and instruments taken, as it were, haphazard by the incessant and consistent forces behind them; they are the pen-nibs Fate has used for her writing, the diamonds upon the drill that pierces through the rock. And the more one inclines to this trust in forces, the more one will believe in the possibility of a reasoned inductive view of the future that will serve us in politics, in morals, in social contrivances, and in a thousand spacious ways. And even those who take the most extreme and personal and melodramatic view of the ways of human destiny, who see life as a tissue of fairy godmother births and accidental meetings and promises and jealousies, will, I suppose, admit there comes a limit to these things, that at last personality dies away and the greater forces come to their own. The great man, however great he be, cannot set back the whole scheme of things; what he does in right and reason will remain, and what he does against the greater creative forces will perish. We cannot foresee him, let us grant that. His personal difference, the splendour of his effect, his dramatic arrangement of events will be his own —in other words, we cannot estimate for accidents and accelerations and delays—but if only we throw our web of generalisation wide enough, if only we spin our rope of induction strong enough, the final result of the great man, his ultimate surviving consequences, will come within our net.

Such, then, is the sort of knowledge of the future that I believe is attainable, and worth attaining. I believe that the deliberate direction of historical study and of economic and social study towards the future, and an increasing reference, a deliberate and courageous reference, to the future in moral and religious discussion, would be enormously stimulating and enormously profitable to our intellectual life. I have done my best to suggest to you that such an enterprise is now a serious and practicable undertaking. But at the risk of repetition I would call your attention to the essential difference that must always hold between our attainable knowledge of the future and our existing knowledge of the past. The portion of the past that is brightest and most real to each of us is the individual past, the personal memory. The portion of the future that must remain darkest and least accessible is the individual future. Scientific prophecy will not be fortune telling, whatever else it may be. Those excellent people who cast horoscopes, those illegal fashionable palm-reading ladies who abound so much to-day, in whom nobody is so foolish as to believe, and to whom everybody is foolish enough to go, need fear no competition from the scientific prophets. The knowledge of the future we may hope to gain will be general and not individual; it will be no sort of knowledge that will either hamper us in the exercise of our individual free will or relieve us of our personal responsibility.

And now, how far is it possible at the present time to speculate on the particular outline the future will assume when it is investigated in this way?

It is interesting, before we answer that question, to take into account the speculations of a certain sect and culture of people who already, before the middle of last century, had set their faces towards the future as the justifying explanation of the present. These were the positivists, whose position is still most eloquently maintained and displayed by Mr. Frederic Harrison, in spite of the great expansion of the human outlook that has occurred since Comte. If you read Mr. Harrison, and if you are also, as I presume your presence here indicates, saturated with that new wine of more spacious knowledge that has been given the world during the last fifty years, you will have been greatly impressed by the peculiar limitations of the positivist conception of the future. So far as I can gather, Comte was, for all practical purposes, totally ignorant of that remoter past outside the past that is known to us by history, or if he was not totally ignorant of its existence, he was, and conscientiously remained, ignorant of its relevancy to the history of humanity. In the narrow and limited past he recognised, men had always been like the men of to-day; in the future he could not imagine that they would be anything more than men like the men of to-day. He perceived, as we all perceive, that the old social order was breaking up, and after a richly suggestive and incomplete analysis of the forces that were breaking it up, he set himself to plan a new static social order to replace it. If you will read Comte, or, what is much easier and pleasanter, if you will read Mr. Frederic Harrison, you will find this conception constantly apparent—that there was once a stable condition of society with humanity, so to speak, sitting down in an orderly and respectable manner; that humanity has been stirred up and is on the move, and that finally it will sit down again on a higher plane, and for good and all, cultured and happy, in the re-organised positivist state. And since he could see nothing beyond man in the future, there, in that millennial fashion, Comte had to end. Since he could imagine nothing higher than man, he had to assert that humanity, and particularly the future of humanity, was the highest of all conceivable things.

All that was perfectly comprehensible in a thinker of the first half of the nineteenth century. But we of the early twentieth, and particularly that growing majority of us who have been born since the "Origin of Species" was written, have no excuse for any such limited vision. Our imaginations have been trained upon a past in which the past that Comte knew is scarcely more than the concluding moment; we perceive that man, and all the world of men, is no more than the present phase of a development so great and splendid that beside this vision epics jingle like nursery rhymes, and all the exploits of humanity shrivel to the proportion of castles in the sand. We look back through countless millions of years and see the great will to live struggling out of the intertidal slime, struggling from shape to shape and from power to power, crawling and then walking confidently upon the land, struggling generation after generation to master the air, creeping down into the darkness of the deep; we see it turn upon itself in rage and hunger and reshape itself anew, we watch it draw nearer and more akin to us, expanding, elaborating itself, pursuing its relentless inconceivable purpose, until at last it reaches us and its being beats through our brains and arteries, throbs and thunders in our battleships, roars through our cities, sings in our music and flowers in our art. And when—from that retrospect—we turn again towards the future, surely any thought of finality, any millennial settlement of cultured persons, has vanished from our minds.

This fact that man is not final is the great unmanageable disturbing fact that rises upon us in the scientific discovery of the future, and to my mind at any rate the question what is to come *after* man is the most persistently fascinating and the most insoluble question in the whole world.

Of course we have no answer. Such imaginations as we have refuse to rise to the task.

But for the nearer future, while man is still man, there are a few general statements that seem to grow more certain. It seems to be pretty generally believed to-day that our dense populations are in the opening phase of a process of diffusion and aëration. It seems pretty inevitable also that at least the mass of white population in the world will be forced some way up the scale of education and personal efficiency in the next two or three decades. It is not difficult to collect reasons for supposing, and such reasons have been collected, that in the near future, in a couple of hundred years as one rash optimist has written, or in a thousand or so, humanity will be definitely and consciously organising itself as a great world State, a great world State that will purge from itself much that is mean, much that is bestial, and much that makes for individual dulness and dreariness, grey-

ness and wretchedness in the world of to-day. And although we know that there is nothing final in that world State, although we see it only as something to be reached and passed, although we are sure there will be no such sitting down to restore and perfect a culture as the positivists foretell, yet few people can persuade themselves to see anything beyond that except in the vaguest and more general terms. That world State of more efficient, more vivid, beautiful and eventful people is, so to speak, on the brow of the hill, and we cannot see over—though some of us can imagine great uplands beyond and something, something that glitters elusively, taking first one form and then another, through the haze. We can see no detail, we can see nothing definable, and it is simply, I know, the sanguine necessity of our minds that makes us believe those uplands of the future are still more gracious and splendid than we can either hope or imagine. But of things that can be demonstrated we have none.

Yet I suppose most of us entertain certain necessary persuasions, without which a moral life in this world is neither a reasonable nor a possible thing. All this paper is built finally upon certain negative beliefs that are incapable of scientific establishment. Our lives and powers are limited, our scope in space and time is limited, and it is not unreasonable that for fundamental beliefs we must go outside the sphere of reason and set our feet upon Faith. Implicit in all such speculations as this, is a very definite and quite arbitrary belief, and that belief is that neither humanity nor in truth any individual human being is living its life in vain. And it is entirely by an act of faith that we must rule out of our forecasts certain possibilities, certain things that one may consider improbable and against the chances, but that no one upon scientific grounds can call impossible. One must admit that it is impossible to show why certain things should not utterly destroy and end the entire human race and story, why night should not presently come down and make all our dreams and efforts vain. It is conceivable, for example, that some great unexpected mass of matter should presently rush upon us out of space, whirl sun and planets aside like dead leaves before the breeze, and collide with and utterly destroy every spark of life upon this earth. So far as positive human knowledge goes, this is a conceivably possible thing. There is nothing in science to show why such a thing should not be. It is conceivable, too, that some pestilence may presently appear, some new disease, that will destroy, not 10 or 15 or 20 per cent. of the earth's inhabitants as pestilences have done in the past, but 100 per cent., and so end our race. No one, speaking from scientific grounds alone, can say—that cannot be. And no one can dispute that some great disease of the atmosphere, some trailing cometary poison, some great emanation of vapour from the interior of the earth, such as Mr. Shiel has made a brilliant use of in his "Purple Cloud," is consistent with every demonstrated fact in the world. There may arise new animals to prey upon us by land and sea, and there may come some drug or a wrecking madness into the minds of men. And finally there is the reasonable certainty that this sun of ours must some day radiate itself towards extinction; that at least *must* happen, it will grow cooler and cooler, and its planets will rotate ever more sluggishly until some day this earth of ours, tideless and slow moving, will be dead and frozen, and all that has lived upon it will be frozen out and done with. There surely man must end. That of all such nightmares is the most insistently convincing.

And yet one doesn't believe it.

At least I do not. And I do not believe in these things because I have come to believe in certain other things,—in the coherency and purpose in the world and in the greatness of human destiny. Worlds may freeze and suns may perish, but there stirs something within us now that can never die again.

Do not misunderstand me when I speak of the greatness of human destiny.

If I may speak quite openly to you, I will confess that, considered as a final product, I do not think very much of myself or (saving your presence) my fellow creatures. I do not think I could possibly join in the worship of humanity with any gravity or sincerity. Think of it. Think of the positive facts. There are surely moods for all of us when one can feel Swift's amazement that such a being should deal in pride. There are moods when one can join in the laughter of Democritus; and they would come oftener were not the spectacle of human littleness so abundantly shot with pain. But it is not only with pain that the world is shot—it is shot with promise. Small as our vanity and carnality makes us, there has been a day of still smaller things. It is the long ascent of the past that gives the lie to our despair. We know now that all the blood and passion of our life was represented in the Carboniferous time by something—something, perhaps, cold-blooded and with a clammy skin, that lurked between air and water, and fled before the giant amphibia of those days.

For all the folly, blindness and pain of our lives, we have come some way from that. And the distance we have travelled gives us some earnest of the way we have yet to go.

Why should things cease at man? Why should not this rising curve rise yet more steeply and swiftly? There are many things to suggest that we are now in a phase of rapid and unprecedented development. The conditions under which men live are changing with an ever-increasing rapidity, and, so far as our knowledge goes, no sort of creatures have ever lived under changing conditions without undergoing the profoundest changes themselves. In the past century there was more change in the conditions of human life than there had been in the previous thousand years. A hundred years ago inventors and investigators were rare scattered men, and now invention and inquiry is the work of an organised army. This century will see changes that will dwarf those of the nineteenth century as those of the nineteenth dwarf those of the eighteenth. One can see no sign anywhere that this rush of change will be over presently, that the positivist dream of a social reconstruction and of a new static culture phase will ever be realised. Human society never has been quite static, and it will presently cease to attempt to be static. Everything seems pointing to the belief that we are entering upon a progress that will go on, with an ever-widening and ever more confident stride, for ever. The reorganisation of society that is going on now beneath the traditional appearance of things is a kinetic reorganisation. We are getting into marching order. We have struck our camp for ever and we are out upon the roads.

We are in the beginning of the greatest change that humanity has ever undergone. There is no shock, no epoch-making incident—but then there is no shock at a cloudy daybreak. At no point can we say, here it commences, now, last minute was night and this is morning. But insensibly we are in the day. If we care to look we can foresee growing knowledge, growing order, and presently a deliberate improvement of the blood and character of the race. And what we can see and imagine gives us a measure and gives us faith for what surpasses the imagination.

It is possible to believe that all the past is but the beginning of a beginning, and that all that is and has been is but the twilight of the dawn. It is possible to believe that all that the human mind has ever accomplished is but the dream before the awakening. We cannot see, there is no need for us to see, what this world will be like when the day has fully come. We are creatures of the twilight. But it is out of our race and lineage that minds will spring, that will reach back to us in our littleness to know us better than we know ourselves, and that will reach forward fearlessly to comprehend this future that defeats our eyes. All this world is heavy with the promise of greater things, and a day will come, one day in the unending succession of days, when beings, beings who are now latent in our thoughts and hidden in our loins, shall stand upon this earth as one stands upon a footstool, and shall laugh and reach out their hands amidst the stars.

THE WEST INDIAN AGRICULTURAL CONFERENCE, 1902.

THE fourth Agricultural Conference under the presidency of Dr. D. Morris, Imperial Commissioner of Agriculture for the West Indies, was held on January 4 to 6. The opening ceremony was attended by the Governor and the chief members of the military and civil services of the Colony. The delegates, some sixty in number, included representatives of the scientific and educational staffs of all the West Indian colonies.

The president delivered an address reviewing the work of the Department of Agriculture during its three years of existence. Under the head of sugar industry, experimental stations were at work at British Guiana, Barbados, Antigua and St. Kitts raising and testing large numbers of seedling canes, and extensive series of experiments were being carried out with manures. The insect and fungoid diseases of the sugar-cane were being carefully worked out, and schemes for central

factories at Barbados and Antigua were gradually taking shape. The diseases of cacao were receiving careful attention, and amongst subsidiary industries the best method of converting lime juice into citrate of lime was being investigated; attempts were being made to establish a trade in sweet potatoes between Barbados and London, to grow Irish potatoes for the London market, and to develop the onion industry in Antigua, Montserrat and Dominica; and plantations of the Central American rubber (*Castilloa elastica*) had been started at Trinidad and Tobago. A bee expert had been employed for several months to visit and advise bee-keepers, and lately an illustrated pamphlet containing information respecting bee-keeping in the West Indies had been published. Very favourable conditions existed in many of the West Indian colonies for raising horses, cattle and small stock, and efforts were being made to improve native breeds by the importation of stallion ponies, Maltese jacks and jennies, pedigree bulls, pigs, sheep, goats and poultry. The direct fruit trade recently established between Jamaica and the United Kingdom by means of a subsidised steamship service had proved entirely successful, and it was difficult to over-estimate the possibilities in this direction, in which many of the smaller West Indian islands might participate.

Agricultural education had formed an important part of the work done; courses of lectures in agriculture were being delivered in all parts of the West Indies to school teachers, and by this means the subject was being introduced into the primary schools. In the higher grade schools and colleges it was sought to establish lectureships in agricultural science; a lecturer had been provided by the Department at Barbados and Jamaica, and favourable reports had been received upon the results of their work. Seven agricultural scholarships had been founded, and it was hoped soon to be able to increase the number in order to afford opportunity to the most promising boys in the smaller islands to obtain sound agricultural teaching. Agricultural schools at St. Vincent, Dominica and St. Lucia had been established, at which seventy boys were being maintained for three or four years free of cost to their parents and carefully trained in the science and practice of agriculture. Attached to the schools were experiment stations, where the boys carry on all light operations and raise a portion of their own food. A series of lectures to planters had been given in Barbados the full text of which would shortly be published. Agricultural shows under the auspices of the Imperial Department of Agriculture were now regularly held at seven of the islands, and these shows were gradually drawing attention to the better cultivation and preparation of produce and bringing prominently into notice the varied resources of the islands.

Besides the journal of the Imperial Department of Agriculture (*West Indian Bulletin*), of which the last number of the second volume was in the press, twelve pamphlets, containing in the aggregate 417 pp., had been published since the last conference. These pamphlets contain information specially applicable to tropical conditions, and 30,000 copies are in course of being distributed. The principal subjects dealt with are:—"The General Treatment of Insect Pests" (first and second editions), "Scale Insects of the Lesser Antilles" (part i.), "Cultivation of Vegetables," "Hints for cooking Sweet Potatoes,"; "Bee-keeping in the West Indies," "Manures and Leguminous Plants at Barbados, 1898–1901," "Hints for School Gardens," "Seedling and other Canes in the Leeward Islands, 1900–1901," "Seedling and other Canes at Barbados, 1901." Of "Nature Teaching" (pp. 12 and 199) 2000 copies have been published and nearly all distributed. The Department contemplates the publication of a fortnightly paper, to be called the *Agricultural News*, containing hints and advice on all points of interest to the West Indies.

The sugar industry was the first subject taken up for discussion by the Conference; short papers were read by those engaged in sugar-cane experiments in the various colonies, summarising the progress made during the past year; a discussion ensued in which the agricultural representatives took an important part. While no seedling could be put forward at present to displace the old and well-tried varieties, it was felt that the progress made encouraged the view that the production of seedlings was destined to play an important part in the future existence of the sugar-cane industry in the West Indies. The accounts given of recent manurial experiments confirmed the importance of active nitrogenous manures, but tended to show that in many soils phosphatic manures did not increase the yield. The general consensus of opinion was in favour of supplementing the experimental station plots by trials upon a large scale on the estates, and this method has been already adopted in several colonies.

The proceedings included important papers by Mr. H. H. Cousins (Government chemist, Jamaica) and Mr. Joseph Shore (Jamaica), on "The Sugar Industry of Jamaica," and accounts of the life-history of the lady bird borer (*Sphenophorus sacchari*), by Mr. Maxwell Lefroy, and of "The Field Treatment of Cane Tops in reference to Fungoid Disease," by Mr. A. Howard.

On the second day, papers on agricultural education were read by Mr. A. B. McFarlane (principal of the Teachers' Training College, Jamaica), Mr. W. R. Buttenshaw (lecturer in agricultural science, Jamaica) and Messrs. J. E. Reece, J. A. Harbin and C. M. Martin, inspectors of schools at Barbados, Grenada and the Leeward Islands. An educational section, with the Bishop of Barbados as chairman and Mr. C. M. Martin as secretary, reported upon questions connected with agricultural teaching at primary schools. A chemical section, with Prof. J. B. Harrison (British Guiana) as chairman and Prof. J. P. d'Albuquerque (Barbados) secretary, reported upon chemical methods in sugar-cane work.

Papers were also read on "Suggestions for Regulating the Quality of Exported Fruit," by Mr. Sydney Olivier (Colonial Secretary, Jamaica), "The Preparation of Citrate of Lime," by Mr. Francis Watts (Government chemist, Leeward Islands), "Scale Diseases," by Mr. H. Maxwell Lefroy (entomologist to the Department), "Agricultural Boards," by Mr. Sydney Olivier, "The Preparation of Essential Oils," by Mr. Hart (Superintendent of the Botanic Gardens, Trinidad), "The Removal of Epiphytic Vegetation on the Stems of Cacao and Lime Trees," by Mr. A. Howard (mycologist to the Department), and "The Aloe Industry of Barbados," by Mr. W. G. Freeman (technical assistant to the Department).

J. P. D'ALBUQUERQUE.

THE LEONID SHOWER OF 1901.

IT now seems possible to give a brief review of the character of the Leonid shower which occurred last November, a considerable number of reports being available for the purpose. Certain other results obtained in various quarters of the globe doubtless still remain unpublished, but it is not likely that they will materially differ from those already before us.

In England the display of Leonids cannot be said to have been a conspicuous or a plentiful one, though it was decidedly stronger than in either of the years 1899 or 1900. Fortunately, the sky was clear on the nights following November 14 and 15, and a large number of observations were secured in different parts of the country. On the morning of November 15, Mr. H. Corder at Bridgwater watched the firmament for an hour and a half and saw 50 meteors, three-quarters of the number being Leonids, so that the horary rate of their apparition was about 25. Mr. E. C. Willis, of Norwich, found the hourly number 22 on the same morning, while on the following morning it was 18. Mr. J. R. Henry, of Dublin, observing from 1h. to 3.30, saw Leonids as bright as the first and second magnitude falling at the rate of 12 per hour. The maximum was apparently attained just before the morning twilight began to overpower the fainter stars. The horary numbers quoted above may be fairly considered to approximate the truth. It is true that some other observers saw fewer meteors, but as they were engaged in recording the individual paths, a considerable number must have altogether escaped their notice.

But the real maximum of the shower certainly occurred after sunrise in England; this is proved by observations from America, where the meteors were far more numerous, though the display was only of secondary importance. Mr. E. L. Larkin, at the observatory on Echo Mountain, S. California, counted 297 meteors on November 15, 4h. to 5h. a.m. (local time), so they were falling at the rate of 5 per minute. The maximum was at about 4h. 20m.–25m. a.m. One fireball left a streak for 14 minutes, and the meteors generally were very brilliant, two being estimated twenty times as bright as Venus, three ten times as bright, twelve five times as bright, and twenty-five equal to Venus. Forty were equal to Jupiter. At Ladd Observatory, Providence, the number seen was 2 per minute on the morning of November 15, while at several other places in the States the rate was 3 or 4 per minute between about 3h. 30m. and 5h. 30m. a.m.

At Carlton College, Northfield, Minn., it was estimated that four observers might have counted about 1600 meteors per hour. There was a marked falling off in numbers on the morning of November 16. Yet at two stations, according to newspaper reports, the shower was quite striking on the latter morning, for at Los Angeles one observer is said to have counted 385 meteors in the hour between 4h. and 5h. a.m., while at Phœnix 200 were seen in half an hour. It is highly probable, however, judging from the character of the shower as recorded at other stations, that in the two latter cases the observations were really made on the morning of the 15th and not on the 16th as stated in the newspaper accounts, which are often erroneous in such matters.

The maximum of the display must have occurred at about 11h. 30m. a.m. G.M.T. November 15, according to some of the best American descriptions. Possibly it may have been attained even later than this, for the morning twilight must have affected the observations to some extent. If the time of greatest frequency was after that stated, the phenomenon at its best could only have been observed from the Pacific Ocean, and it is not probable that we shall get any satisfactory reports from this region.

Though the shower was pretty active, it does not appear that photography has afforded any material assistance in recording its features. Plates were exposed at many observatories, but trails were absent upon them except in one or two isolated instances.

In England a number of meteors were doubly observed during the Leonid epoch, and their real paths have been calculated. In the following table are given the heights, &c., of 8 Leonids, of 1 Leo Minorid, of 1 δ Leonid, and of a remarkably slow-moving meteor from Cetus :—

Date. 1901.	G.M.T. h. m.	Mag.	Height at beginning. Miles	Height at ending. Miles.	Path. Miles.	Velocity per second. Miles.	Radiant point. α δ (° °)
Nov. 14	13 32	1 − >1	85	52	66	Rapid	156+32
	13 37½	2 − 1	77	57	38	Rapid	152+30
	13 42	♃ − ♀	81	67	67	55	174+20
	14 24	4 − 2	82	57	44	Rapid	152+25
	14 38	2 − 2	67	54	22	37	152+23
	15 7	3 − 1	95	55	60	Rapid	152+23
	15 23	>1 − ♃	72	47	36	72	151+25
	16 0	1 − >1	91	61	41	54	149+20
	16 7	1	86	60	35	Rapid	151+23
Nov. 15	13 8	1½ − 1	43	37	28½	7¾	38−21
	13 48	2 − ♃	76	59	37	37	151+21

The mean height of 8 true Leonids was 81 to 56 miles and the mean radiant-position $151^{\circ}\cdot2+23^{\circ}\cdot7$.

The place of the radiant found by Mr. Winslow Upton at the Ladd Observatory, Providence, was on November 15 a.m. $150\frac{3}{4}^{\circ}+21\frac{1}{2}^{\circ}$, and on November 16 a.m. $151^{\circ}+21\frac{1}{4}^{\circ}$.

The next return of the Leonids will be regarded in an interesting light, for 1902 will afford the 1000th anniversary of the first record of the shower (902). The moon will be full at the middle of November, but as the meteors of this swarm are often brilliant, some of them are likely to be distinguished in spite of the illuminated sky. There were showers of Leonids in 902, 1002, 1202 and 1602, and the revival of the display in 1901 encourages the hope that something may be seen of it in 1902, though the parent comet will be about three and a half years past its perihelion.

W. F. DENNING.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

OXFORD.—The 231st meeting of the Junior Scientific Club was held on January 31. Two papers were read, one by Prof. H. A. Miers, F.R.S., Magdalen, on gold-mining in Klondike, and the other, by Mr. H. L. Tidy, New College, on some curious sounds. The officers of the Club for this term are:—President, Mr. H. H. Cooke, New College; biological secretary, Mr. E. Burstal, Trinity; chemical secretary, Mr. S. P. Grundy, Balliol; treasurer, Mr. E. L. Kennaway, New College; editor, Mr. H. D. Davis, Balliol.

IN reply to a question in the House of Commons on Monday as to the approximate date of the introduction of the Education Bill promised in the King's Speech, Mr. Balfour said he was unable to give a date, but he hoped the Bill would be introduced before Whitsuntide.

CORRESPONDENCE classes in various branches of engineering have been successfully carried on in the United States for several years. Prof. Andrew Jamieson, late professor of electrical engineering at the Glasgow Technical College, has now established similar classes in Glasgow for students of electrical and machanical engineering. We are glad to notice that all students are advised to take a course of practical mathematics before devoting themselves to other subjects.

THE annual general meeting of the Association of Technical Institutions was held on Friday last in London. Lord Avebury, the president for the ensuing year, delivered an address in which he showed that the system of technical and higher education in Germany had been to the industrial advantage of the nation. If Britannia is to rule the waves she must be able to rule the steam engine and dynamo as well. Resolutions were adopted to the following effect:—(*a*) That this Association strongly approves the general principles on which the Government Education Bill of 1901 was based, and trusts that the Government will carry a Bill embodying these principles, with such amendments as may prove necessary, in the next session of Parliament. (*b*) That the Bill should prescribe that the residue under section 1 of the Local Taxation Account (Customs and Excise) Act, 1890, including any balance thereof which may remain unexpended at the end of the financial year, shall be applied for the purposes of education, and shall be administered by the education authority. (*c*) That an extension of the rating power by only 1d. in the pound, as was proposed in the Bill of 1901, would be wholly inadequate—especially in the case of the county boroughs—to defray the necessary additional charges in respect of secondary education which would fall upon the local authorities. (*d*) That it should be made a condition of the application of the residue under section 1 of the Local Taxation (Customs and Excise) Act, 1890, to the purposes of secondary education in general, that adequate provision shall first have been made for technical instruction, as was done in clauses one (1) and two (1) of the Duke of Devonshire's Education Bill of 1900. (*e*) That the Government should at once introduce and pass a Bill placing primary, secondary and technological education under the supervision of one local authority appointed as a rule for an area not less than that of a county or a county borough.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, January 23.—"On the Causation of the so-called 'Peripheral Reflex Secretion' of the Pancreas. (Preliminary Communication.)" By W. M. Bayliss, D.Sc. and Ernest H. Starling, M.D., F.R.S.

Introduction.—It has long been known that the introduction of acid into the duodenum causes a flow of pancreatic juice, and it has been shown recently by Popielski, and by Wertheimer and Le Page, that this flow still occurs after nervous isolation of duodenum and pancreas. Wertheimer also mentions that the flow can be excited by injection of acid into the jejunum, but not by introduction of acid into the lower part of the ileum. These authors conclude that the secretion is a local reflex, the centres being situated in the scattered ganglia of the pancreas, or, in the case of the jejunum, in the ganglia of the solar plexus (Wertheimer).

Results.—The secretion excited by introduction of acid into the jejunum cannot be reflex, since it occurs after extirpation of the solar plexus and destruction of all the nervous filaments passing to the isolated loop of jejunum. It also occurs after intravenous injection of 0·01 gramme atropin sulphate. It must therefore be due to direct excitation of the gland cells be a substance or substances conveyed to the gland from the bowel by the blood stream.

The exciting substance is not acid. Wertheimer has shown that injection of 0·4 per cent. HCl into the blood stream has no excitatory influence on the pancreas.

The secretion must therefore be due to some substance produced in the intestinal mucous membrane under the influence of the acid, and carried thence by the blood stream to the gland. This conclusion was at once confirmed by experiment.

When the mucous membrane of the jejunum or duodenum is exposed to the action of 0·4 per cent. HCl a body is produced which, when injected in minimal doses into the blood stream,

produces a copious secretion of pancreatic juice. This body, which for the present is termed *secretin*, is associated with another body with a pronounced lowering effect on the blood pressure. The two bodies are not identical, since acid extracts of the lower end of the ileum produce the pressure-lowering effect, but have no excitatory influence on the pancreas.

Observations indicate that *secretin* is probably a body of very definite composition, and of small molecular weight. Dr. Osborne is at present engaged in an investigation of its chemical characters and identity.

"On the Excretory Organs of Amphioxus." By Edwin S. Goodrich, M.A., Fellow of Merton College, Oxford. Communicated by E. Ray Lankester, F.R.S.

Linnean Society, January 16.—Prof. S. H. Vines, F.R.S., president, in the chair.—Mr. Alfred O. Walker exhibited some branches of cherry affected with a fungus disease caused by *Gnomonia erythrostoma*.—Mr. J. E. Harting exhibited some heads of wild sheep, together with photographs and lantern-slides, to illustrate a recent suggestion as to the use and value of spiral horns in feral species. Dr. George Wherry, of Cambridge, who originated the discussion and was present as a visitor, selected *Ovis nivicola* of Kamtschatka as a typical species to support his theory, and pointed out that while the horns were enormous, the ear was remarkably short, situated exactly in the axis of the spiral, and, as it were, at the apex of a hollow cone formed by the great spiral horn. This he regarded as a provision of Nature to enable the animal to hear better and to determine the direction of sounds when there is a mist or fog, the horn acting like an Admiralty megaphone when used as an ear-trumpet. Mr. Harting pointed out that the remarkably large spiral horns were peculiar to the male sex, and that if they were to be regarded as of use for the preservation of the species, the ewes, which required the most protection, would be in that respect defenceless. This would be especially the case with *Ovis nivicola*, the sexes of which, according to Dr. Guillemard ("Voyage of the *Marchesa*," vol. i. p. 214), lived apart in small herds for some portion of the year. It was a significant fact, also, that wild sheep, like other wild animals, posted sentries whilst feeding to prevent being surprised by their enemies, and it was the experience of those who hunted them that when approached the alarm was generally given by a ewe. He thought that wild sheep and goats, like deer, relied more upon their sense of sight and smell than upon their hearing, and that the large horns, like those of other ruminants, were simply weapons of defence against wild carnivora, and of offence against rivals during the breeding-season, as in the case of deer. Dr. Wherry, in reply, thought it would be found, in the case of ewes in which the horns were either absent or rudimentary, that the ears, by way of compensation, were much larger than those of the rams; but he had been unable to find anywhere a head of a female *Ovis nivicola* for examination.—Messrs. H. and J. Groves read a paper on the use of Linnean specific names. They showed that great diversity of practice existed in dealing with these names, and pointed out the necessity of arriving at some agreement as to their use as a first step towards uniformity in nomenclature. They grouped the Linnean specific names under the following heads:—(1) Those applied to distinct species fairly well understood in Linnæus's time, and still generally accepted. (2) Those which are now considered to include two or more species, combined by Linnæus owing to either (*a*) the imperfect knowledge of the plants at the time, or (*b*) the different ideas then and now as to the extent of species. (3) Those about which there is more or less doubt as to their proper application, owing to (*a*) the descriptions being imperfect, (*b*) the synonymy (often the most important part of the description) being contradictory, or (*c*) confusion due to changes made by Linnæus himself after publication. After discussing the various methods adopted and the difficulties connected with each, Messrs. Groves recommended that in doubtful cases, so far as possible, the description in conjunction with the reference to earlier authors should be relied on, always construing the species liberally, and that when the specimens in the Linnean herbarium or amendments in the second edition of "Species Plantarum" are at variance with this conception of the species, they should be disregarded. As regards group 2, they recommended that the name should be retained for the type if specified, or if not to the species which may be most fairly regarded as the type, and in the absence of such to the residuary species after others had been cut off; and as regards group 3, that unless the evidence is hopelessly vague, or contradictory, the names should be retained for the species for which the weight of evidence points to their having been intended. Specimens were exhibited of the plants which, following the practice advocated, would stand as *Hypericum quadrangulum*, L., *Epilobium alpinum* and *E. tetragonum*, L., and *Sparganium erectum*, L., also of the allied species in each case bearing on the question.

CAMBRIDGE.

Philosophical Society, January 20.—Prof. Macalister, president, in the chair.—On the question of "predisposition" and "immunity" in plants, by Prof. H. Marshall Ward, F.R.S. The author directed attention to previous work by himself and others which indicates that plants are not merely passive to the attacks of parasites, and especially referred to experiments with the rust fungi (Uredineæ) which clearly show that not only do these parasites vary and differ in their powers of adaptation to different hosts of the same species or genus, but the hosts exert definite reactions on the fungi. In particular, the results of a large series of infection experiments made by the author with the uredo of *Puccinia dispersa*, the brown rust of the bromes, were summarised. During the past summer more than 1800 such experimental infections were made on twenty-two varieties and species of Bromus, belonging to four out of the five subgenera. The infecting spores were derived from three different species of Bromus. The results show distinctly that not only does the power of the fungus to attack a given species of the flowering plant depend on the specific nature of the latter, but it also depends on the specific nature of the previous host on which the spores were produced. The conclusion is arrived at that specific predisposition and immunity in plants depend on similar internal mechanisms and conditions to those which determine the possibility or otherwise of cross-fertilisation, and just as this possibility varies and may be increased or diminished by inheritance in breeding, so may the capacity of resistance to infection vary and be increased or diminished in different races. It is probable that secretions of enzymes, chemotactic substances, toxins and antitoxins in the cell play a part in all such processes.—On the genito-urinary organs of dipnoan fishes, by Mr. Graham Kerr.—Further observations on the biological test for blood, by Mr. George H. F. Nuttall. The paper refers to studies of what the author terms "blood-relationship" amongst animals by means of test-tube reactions with various anti-sera. The results of the investigation of some 440 species of blood go to show that the biological test for blood may possess considerable value in relation to zoological study.

MANCHESTER.

Literary and Philosophical Society, January 21.—Mr. Charles Bailey, president, in the chair.—Mr. W. E. Hoyle made some remarks on a case of failure of concrete flooring strengthened by steel bands.—A paper, entitled "On *Xenophyton radiculosum* (Hick), and on a stigmarian rootlet probably related to *Lepidophloios fuliginosus* (Williamson)," was read by Prof. F. E. Weiss. He gave his reasons for regarding the fossil Xenophyton, described by the late Thomas Hick in 1891, as a stigmarian "root" or rhizome, which, on account of the peculiar structure of its vascular cylinder and of its massive and well-preserved middle cortex, he considered to be closely allied to the lepidodendroid stem known as *Lepidophloios fuliginosus*. He also described a stigmarian rootlet, which he considered to be related to Lepidophloios. This rootlet was further remarkable on account of the presence, in its well-preserved cortex, of a vascular branch similar to that described for stigmarian rootlets of a different type by Renault. Prof. Weiss stated that he had been able to confirm the occurrence of such branches from the central cylinder in several other stigmarian rootlets, in the collection of the Manchester Museum.

EDINBURGH.

Royal Society, December 16, 1901.—Prof. Geikie in the chair.—Dr. T. J. Jehu read a paper on a bathymetrical and geological study of the lakes of Snowdonia and eastern Carnarvonshire. It was clearly demonstrated that ice action had been an important factor in the formation of many of the valleys and lakes of the district, although at the same time it was also evident that other geological agents had been at work. The comparatively great depth of certain of the lakes, of which

sixteen had been studied in detail, left no doubt as to their glacial origin.

January 6.—Sir W. Turner in the chair.—A paper by Mr. F. Fraser, on a theoretical representation leading to general suggestions on the ultimate constitution of matter and ether, was communicated by Prof. Chrystal. The fundamental novelty was the conception of an atom of matter as a kind of ether bubble. The ether was supposed to be an assemblage of rapidly moving corpuscles rebounding after collision without loss of energy, and in this a spherical vacuity was produced forming the atom, the corpuscles in the spherical surface being kept circulating in the surface by the impacts of the corpuscles from outside, which on their part were unable to penetrate within the sphere because of the barrier of swiftly moving corpuscles in the surface. The author believed that this hypothesis gave the gravitation law of attraction between two neighbouring bubbles. The paper also contained speculations relating to valency in chemistry.—A paper was read by Dr. D. H. Scott on the primary structure of certain Palæozoic stems with the dadoxylon type of wood. The principal result of the investigation, as a whole, was to show that in a number of stems of Palæozoic age with secondary wood of the well-known dadoxylon type there were around the pith distinct usually mesarch strands of primary xylem, forming the downward continuation of the leaf-trace bundles. Hence, the anatomical structure typically represented by *Lyginodendron Oldhamii* proves to have been widely distributed among Palæozoic plants, and to have been common to stems which on other grounds would be reasonably referred to Cordaiteæ. Thus new links have been found connecting this gymnospermous family with the Cycadofilices, and through them with some primæval group of ferns.—Dr. Thomas Muir communicated a paper on a continuant resolvable into rational factors, and a note on selected combinations.—Dr. Hugh Marshall read a note on a suggested modification of the sign of equality in chemical notation, in which he proposed that in chemical equations representing actions which actually occur the sign of equality should be composed of singly barbed arrows arranged so as to differentiate the most important varieties of chemical action. The symbols suggested were : $\Longrightarrow$, $\rightleftharpoons$, $\Longleftrightarrow$, $=\!=\!=$, the first for irreversible actions, the second for reversible actions, such as dissociation, &c., the third for reversible actions with definite transition point (in which case the temperature might be stated above the symbol), and the fourth for reversible actions which, under the conditions of the experiment, are practically completed in the direction indicated, so that the reversible character of the action is not of immediate importance. It might also be used in doubtful cases.

PARIS.

Academy of Sciences, January 27.—M. Bouquet de la Grye in the chair.—An apparatus for measuring the variations of small zenithal distances, by M. G. Lippmann. The apparatus described makes the zenith visible in the field of observation as a small artificial star, which shows amongst the real stars. It possesses the advantages of requiring no special regulation or stability, and visual observations may be replaced by photography.—On some properties of the radiation from radioactive bodies, by M. Henri Becquerel. It has been shown in earlier papers that radium rays are divided into two groups in a strong magnetic field, one part being not affected and giving a strong impression on a photographic plate, the other being deviated in a manner similar to the kathode rays. No portion of the polonium rays is deviable. An analogous experiment has now been made with uranium. The times of exposure were necessarily very long, twenty and forty-two days in two experiments. The whole of the uranium rays appear to be deviated, the non-deviable portion, if it exists, being of an intensity which is negligibly small compared to the whole radiation. This would appear to show a fundamental difference between uranium and radium. It has been previously found that the dark radiation from radium is capable of transforming white into red phosphorus, and analogous experiments with uranium showed that the uranium rays possess the same property.—On the preparation of tantalum in the electric furnace and on its properties, by M. Henri Moissan. An alloy of niobium and tantalum was first prepared by reducing niobite with sugar charcoal in the electric furnace; this was then converted into fluotantalate and fluoniobate of potassium, and these salts separated by Marignac's method. The tantalic acid prepared in this way was then reduced with charcoal in the electric furnace in a graphite crucible. Metallic tantalum was thus obtained containing only a small quantity of carbon as impurity, as a brilliant metallic mass, with a crystalline fracture, of density 12·79. Its behaviour towards various chemical reagents is given in detail.—On a class of rational transformations, by M. Ivar Fredholm.—On the resolution of singular points of algebraic surfaces, by M. Beppo Levi.—The experimental definition of the different kinds of X-rays by radiochromometry, by M. L. Benoist. The unequal variations of transparency of two different bodies is utilised, when the quality of the X-rays changes, to define a series of qualities of rays by a series of relative transparencies, for example, of aluminium with respect to silver. The scale of rays thus constituted is always comparable to itself, when the two bodies and their thicknesses are defined.—On an apparatus for automatically registering discharges in the atmosphere, by M. J. Fényi. A coherer and a bobbin are inserted in the circuit of a Meidinger cell. A magnetised needle is placed in the centre of the bobbin, and this is deviated and closes the registering circuit when the coherer becomes conducting owing to a discharge.—On the vapour pressures of hydrogen selenide and the dissociation of its hydrate, by MM. de Forcrand and Fonzes-Diacon. The vapour pressures were measured at four points, $-42°$, -30, $0°·2$ and $30°·8$, and from these a curve was constructed. From this the heat of vaporisation was calculated by means of the Clapyron formula. A similar set of determinations was made for the hydrate.—On lithium antimonide and on the preparation of some alloys of lithium, by M. P. Lebeau. Lithium and antimony readily combine, giving rise to a large development of heat, but the violence of the reaction is so great that a definite compound could not be obtained in this way. But the electrolysis of a mixture of the chlorides of lithium and potassium with a kathode of antimony readily gives a definite crystallised antimonide of the formula $SbLi_3$. The same method can be applied to the preparation of a certain number of other alloys of lithium.—The action of copper hydrate on aqueous solutions of metallic salts, by M. A. Mailhe.—Contribution to the study of the aluminium-iron and aluminium-manganese alloys, by M. Léon Guillet.—On glyceroarsenic acid, by M. V. Auger. Arsenic acid and glycerol readily react, producing acid esters with the elimination of one or two molecules of water, but the product obtained is immediately hydrolysed on contact with cold water.—On the assimilation of lactic acid and of glycerol by *Eurotyopsis Gayoni*, by M. P. Mazé.—On the modifications of the segmentary organs of Syllis, and their functions, at the stage of reproduction, by M. G. Pruvot.—On the mechanism of the formation of the purple of molluscs, by M. Raphael Dubois. The production of the colour would appear to be due to two substances, one of which is a macrozymase, to which the name of purpurase is given. The action of light is necessary to the production of the purple.—On the physiological effects of the poison of the filaments and tentacles of the Cœlenterata, by MM. P. Portier and Charles Richet.—The apolar and closed divergent chains in ferns, by MM. C. Eg. Bertrand and F. Cornaille.—On the withering of vines caused by *Coepophagus echinopus*, by MM. L. Mangin and P. Viala.—The study of the daily variations of the meteorological elements in the atmosphere, by M. L. Teisserenc de Bort.—On the origin and age of the spring of Vaucluse, by M. E. A. Martel.

NEW SOUTH WALES.

Royal Society, December 4, 1901.—Prof. T. W. E. David, F.R.S., vice-president, in the chair.—The gums, resins and other vegetable exudations of Australia, by Mr. J. H. Maiden. The author gives a list of natural orders which in Australia yield both gums and resins, classifying them according as the gum or resin is the predominating substance. The paper contains a tentative list of those orders which yield kinos, and a list is given of those exudations which specially merit the attention of the research chemist. Then follows the main portion of the paper, which contains notes on all the exudations known to the author, arranged in botanical sequence.—On the principle of continuity in the generation of geometrical figures in homaloidal space of n-dimensions, by Mr. G. H. Knibbs. The author discussed the philosophical basis of the idea of the continuous generation of geometrical figures, and showed that we are compelled to admit the conceptional existence of a space of different orders, as well as dimensions, of infinity and zero, the interpretation of such being in all cases unambiguous.—Some theorems, concerning geometrical figures in space n dimensions, whose $(n-1)$ dimensional generatrices are n^{ic} functions of their position

on an axis, straight, curved, or tortuous, by Mr. G. H. Knibbs. In this paper the author showed that certain theorems developed in two previous papers might be extended greatly in generality, and were applicable to *quanta* determinations in n-dimensional space.—Rock-holes used by the aborigines for warming water, by Mr. R. H. Mathews. The author showed that the natives were in the habit of immersing heated stones in small quantities of water for the purpose of warming it for drinking, and in some cases to assist in cooking their food.—Some aboriginal tribes of Western Australia, by Mr. R. H. Mathews. Mr. Mathews also contributed an article on some aboriginal tribes of Western Australia, describing their divisions into intermarrying sections; lists of totems, comprising animals, plants and other natural objects, attached to each of the sections, were also given. The laws regulating marriage and descent were explained, together with a brief outline of the structure of the language. Mention was made of their legends, knowledge of the cardinal points, and customs of genital mutilation, the whole concluding with a comprehensive vocabulary.—Projects for water conservation, irrigation and drainage in New South Wales, by Mr. H. G. McKinney.

ST. LOUIS.

Academy of Science, January 6.—Mr. Henry W. Eliot, president, in the chair.—On behalf of herself and a considerable number of other persons, Mrs. William Bouton presented to the Academy a collection of 633 butterflies mounted on Denton tablets, on condition that the collection should be made accessible to the public. The following papers were presented by title:—New species of plants from Missouri, by Messrs. K. K. Mackenzie and B. F. Bush.—Revision of the North American species of Triodia, by Mr. B. F. Bush.—Prof. A. S. Chessin exhibited a gyroscope and explained how an accurately constructed and rapidly rotated gyroscope might be made to indicate the position of the meridian plane, the direction of the polar axis of the earth and the latitude of the place of observation, thus serving the purpose of the mariner's compass, but more accurately, because of the fact that the compass indicates the magnetic pole and not the true pole. The following formulæ pertaining to the subject were furnished:—

$$T=\pi\sqrt{\frac{A+C_1+A_2}{C\omega\Omega\cos\lambda}} \qquad T^1=\pi\sqrt{\frac{A+C_1+A_2}{C\omega\Omega}},$$

where T and T^1 are the durations of a complete oscillation of the gyroscope when its axis is made to remain in the horizontal and the meridian planes respectively; ω and Ω the angular velocities of rotation of the earth and the gyroscope respectively; A, A_1, A_2 and C, C_1, C_2 the equatorial and the axial moments of inertia of the gyroscope and the two rings on which it is mounted. From these formulæ the latitude (λ) of the place of observation is derived, namely:—

$$\cos\lambda=\frac{T^{12}}{T^2}.$$

—Prof. F. E. Nipher made a further statement concerning his results in the attempt to produce ether waves by the explosion of dynamite. He had obtained some results which seemed to show that magnetic effects could be thus produced.

DIARY OF SOCIETIES.

THURSDAY, FEBRUARY 6.

ROYAL SOCIETY, at 4.30.—The Stratifications of Hydrogen: Sir William Crookes, F.R.S.—The Density and Coefficient of Cubical Expansion of Ice: Dr. J. H. Vincent.—On the Increase of Electrical Resistivity caused by alloying Iron with various Elements, and the Specific Heat of those Elements: Prof. W. F. Barrett, F.R.S.—Continuous Electrical Calorimetry: Prof. H. L. Callendar, F.R.S.

SOCIETY OF ARTS, at 4.30.—The Coal Resources of India: Prof. W. R. Dunstan, F.R.S.

LINNEAN SOCIETY, at 8.—On a Method of Investigating the Gravitational Sensitiveness of the Root-tip: F. Darwin, F.R.S.—An Extinct Family of Ferns: Dr. D. H. Scott, F.R.S.

CHEMICAL SOCIETY, at 8.—An Investigation into the Composition of Brittle Platinum: W. N. Hartley.—Conversion of l-Hydroxycamphene into β-Halogen Derivatives of Camphor: M. O. Forster.—Tetrazoline, Part II.: S. Ruhemann and H. E. Stapleton.—(1) The Solubilities of the Calcium Salts of the Acids of the Acetic Acid Series; (2) The Equilibrium between a Solid and its Saturated Solution at various Temperatures: J. S. Lumsden.—The Influence of Temperature on Association in Benzene Solution, and the Value of the Molecular Rise of Boiling Point for Benzene at Different Temperatures: W. R. Innes.—The Magnetic Rotation of Ring Compounds; Camphor, Limonene, Carvene, Pinene, and some of their Derivatives: W. H. Perkin, sen., F.R.S.—Polymerisation Products from Diazoacetic Ester: O. Silberrad.

RÖNTGEN SOCIETY, at 8.30.—A System of Radiography: E. W. H. Shenton.

FRIDAY, FEBRUARY 7.

ROYAL INSTITUTION, at 9.—The New Mammal from Central Africa and other Giraffe-like Animals: Prof. E. Ray Lankester, F.R.S.

GEOLOGISTS' ASSOCIATION, at 7.30.—Annual General Meeting.—Address on a Dozen Years of London Geology (Eocene, Chalk, and Underground): W. Whitaker, F.R.S., President.

MONDAY, FEBRUARY 10.

SOCIETY OF ARTS, at 8.—Personal Jewellery from Prehistoric Times: Cyril Davenport.

IMPERIAL INSTITUTE, at 8.30.—The Coloured Races in Australia: Hon. Sir Horace Tozer, K.C.M.G.

ROYAL GEOGRAPHICAL SOCIETY, at 8.30.—The Ancient Kingdom of Kongo; Rev. Thomas Lewis.

TUESDAY, FEBRUARY 11.

ROYAL INSTITUTION, at 3.—The Cell: its Means of Offence and Defence: Dr. A. Macfadyen.

INSTITUTION OF CIVIL ENGINEERS, at 8.—The Port of Dundee: G. C. Buchanan.

WEDNESDAY, FEBRUARY 12.

SANITARY INSTITUTE, at 8.—Discussion on the Prevention of Small-Pox in the Metropolis: Opened by A. Wynter Blyth.

THURSDAY, FEBRUARY 13.

ROYAL SOCIETY, at 4.30.

INSTITUTION OF ELECTRICAL ENGINEERS, at 8.—Researches on the Electrical Conductivity and Magnetic Properties of upwards of 100 different Alloys of Iron: Prof. W. F. Barrett, F.R.S., and W. Brown.—On some Conclusions deduced from the preceding Paper: Prof. W. F. Barrett, F.R.S.

MATHEMATICAL SOCIETY, at 5.30.—On the Density of Linear Sets of Points: W. H. Young.—On Plane Cubics: Prof. A. C. Dixon.

FRIDAY, FEBRUARY 14.

ROYAL INSTITUTION, at 9.—Magic Squares and other Problems on a Chess Board: Major P. A. MacMahon, F.R.S.

PHYSICAL SOCIETY, at 5.—Annual General Meeting.—Address by the President, Prof. S. P. Thompson, F.R.S.—Mr. T. H. Littlewood will exhibit an Atwood's Machine.

ROYAL ASTRONOMICAL SOCIETY, at 3.—Annual General Meeting.

MALACOLOGICAL SOCIETY, at 8.

INSTITUTION OF CIVIL ENGINEERS, at 8.—Some Public Health Aspects of the Question of Sewage Disposal: C. Johnston.

SATURDAY, FEBRUARY 15.

ROYAL INSTITUTION, at 3.—Some Electrical Developments: Lord Rayleigh, F.R.S.

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THURSDAY, FEBRUARY 13, 1902.

THE CAMBRIDGE SCHOOL, AND A ZOOLOGICAL TEXT-BOOK.

Zoology, an Elementary Text-Book. By A. E. Shipley, M.A., of Cambridge, and E. W. McBride, M.A. (Camb.). D.Sc. (Lond.), of Montreal. Pp. 616 ; 349 text-figures. (Cambridge: University Press, 1901). Price 10*s.* 6*d.* net.

YET another elementary text-book of zoology ! The accumulation of facts in zoology during the last quarter of a century has been so overwhelming, that it becomes most difficult even to gauge the capacity of a book like the present, which deals broadly with the whole field. Choice of subject-matter is so wide, selection so difficult, that, in the endeavour to form an estimate of such a work, the mere determination on the part of the reviewer of a standard of comparison upon which to judge it, is in itself an arduous task. Let it be said, however, that the senior author of the present volume has an established reputation as a text-book writer, and that his previous achievements have led us to expect a sometimes thinnish mode of treatment. While in this we are not disappointed, under the joint authorship a very creditable book has been produced.

There are twenty-three chapters in all, the first of which is an "introduction" dealing with broad principles and first definitions. The contents and style of this are such as might be expected from a well-trained first-year man, and are apt to create a false impression of the rest of the book. This simplicity of treatment, however, is intentional, and expressive of the authors' scheme—for they tell us they have aimed at producing a book which can "be readily understood by a student who had no previous knowledge of the subject," and that the phraseology of the later portions of the work is relative to the earlier. Technical terms are explained as they occur, with roots in original Greek, and with fuller definitions where necessary. "Biogen" is introduced as denoting the living molecule. Histology, embryology and palæontology are intentionally placed at a discount, the treatment of classification, and of adult structure "as the outcome of function and habit," being the guiding principle. The several sections of the work treat each of selected individuals of a phylum, and the position and interrelationships of these in the general scheme of classification are for each section concisely stated, with a short diagnosis, in an accompanying table—an arrangement favourable to lucidity in the text, of which the authors have made the most.

Following the introduction are chapters on the Protozoa, Cœlenterata and Porifera. The Cœlomata are ushered in with an introduction special to themselves, and the leading Invertebrate phyla—viz. the Annelida, Arthropoda, Mollusca, Echinodermata, and Chætognatha—are in order dealt with. Seven chapters are next devoted to the Vertebrata ; and there are reserved for the four which conclude the volume the Platyhelminthes, Nemertinea, Rotifera and Nematoda, regarded as phyla which cannot be definitely asserted to be Cœlomata. A decidedly novel arrangement this ! but, under it, the Entoprocta (barely mentioned on p. 286) appear to have escaped adequate recognition, which is the more remarkable since the Chætognatha are accorded some three or four pages.

As a whole, the book is well written and up to date, and of the illustrations, those which are new are mostly good, those borrowed well chosen. Diagrams are given, especially where dealing with the circulatory system, and some of those of the venous channels might well be improved. There pervades the pages of the work a freshness of style and unconventionality which render them pleasant reading and attractive ; while, in the frequent allusion to the commonest occurrences of daily life and human affairs, the interest of the reader is assured. The chapters on the Porifera and Annelida may be cited as thin and inadequate, there being no mention of the horny sponges, of the genus Oscarella, or of the branchiate Oligochætes. Correspondingly slender is the treatment of the "Anacanthini" and Insectivora, the paragraphs upon which are miserably poor. Of definitions, that of the Cyclostomata may be instanced as erroneous, in the non-recognition of the Bdellostomoid forms possessed of more than seven pairs of gill pouches, and the statements concerning the "bile-duct" and the branchial basket-work (by comparison with p. 347), Dohrn having shown the "extra-branchials" to be extended gill-rays.

The description of the pancreas as a mere "outgrowth from the intestine" is insufficient, by non-recognition of its compound origin, now demonstrated for all gnathostomatous groups ; and, similarly, it is nowhere stated that the pulmonary artery is now known to be in all its forms a derivative of the fourth branchial arch. Nor is there mention of the highly significant transitional conditions of the heart (conus and its valves) occurring among the Clupesoces. Again, a most important point is lost in the ignoring of the circular type of the so-called semicircular canals, and the invariably saccular innervation of that which is posterior. And, finally, to pass to minor misstatements, we would remark that the forwardly directed process of the chelonian shoulder-girdle is a scapular derivative (proscapula) occurring only in these creatures and the Plesiosauria ; that the epipterygoid (columella) is not confined to the Lacertilia ; that the pre-hallux of the Batrachia is not definitely proved to be a digit homologous with the rest ; and that the bone which suspends the ophidian mandible is most certainly the supra-temporal.

We are also of opinion that too full an assurance is attached to the supposed quadripartite nature of the "arco-centrum." This, as a vertebral theory, was elaborated at Cambridge ; and we similarly find the Balanoglossoid, also favoured of the Cambridge school, set forth with all its best traditions—but why not Cephalodiscus and Rhabdopleura as well? They are not even mentioned.

One of the most noteworthy features of this book is the tardy recognition of the facts of comparative embryology and palæontology, and it is the more remarkable that the subordination of the former in a work written by two Cambridge men, should have been decided upon, at a time when embryological discovery of far-reaching significance is being made known. In this book the treatment of even larval forms is but casual and passing,

and were the discovery (now fifty years old) of the test-bearing protrochal stage of Dentalium, lately observed by Drew to be passed through by Yoldia and by Pruvot by a Dondersia, but recognised, we should not find the Chitons referred to a subclass of the Gastropoda and the "Solenogastres" accorded a class distinction. To this developmental stage, the discovery of which has dealt the death-blow to the idea of a Rhipidoglossan affinity of the Pelecypoda, and which, we trow, will ere long be extended to other groups, our authors should have directed attention. Had they done so, but three lines would not have sufficed for the Scaphopoda, and Spirula would not have been dismissed as a mere name.

Turning to palæontology, the non-recognition of the recent discovery in the Trilobites of nauplius characters deprives the authors' treatment of this larva of all force. And, similarly, had the Eurypterid forms recently described by Holm from the Russian Silurian, by Beecher from the Cambrian, and the Scorpionid genus Palæophonus, met with recognition, Limulus could not in justice have been once more relegated to the Arachnida. The absence in the present book of all mention of the Odontorinthes and Archæopteryx, of the Anomodontia, the Plesiosauria, and other leading fossil forms which might be named, is a serious omission, but even this does not excuse the non-reference to so important a group as the living Sphargidæ. Embryology and palæontology are branches of morphology coequal with the rest, and, so far as they reveal facts of primary significance, they should be dealt with as elementary subjects. Lack of appreciation of this principle is the weakest feature of the present work, which is, curiously enough, written with a special view to the requirements of the American student, who, of all beginners, is brought up in a palæontological air, and for whose benefit examples, wherever possible, are drawn from American as well as British animals.

Allowing for this serious defect, the book can be confidently recommended as well written and trustworthy, so far as it goes. It has been compiled at great pains, and its style leaves little to be desired. We wish it success and a speedy passage into a second edition; and, in anticipation of this, we would recommend to the authors' consideration the need of revision of such definitions as that of the endoderm cell (p. 48) as "tall"; of the blood-vessels (p. 89) as "chinks"; the replacement of the term "rudiment" on p. 259 by blastema; and certain other loosenesses which are self-evident. It is pertinent to this to remark that in some of their recent attempts at revised terminology, the zoologists of the Cambridge school have been none too successful. Thus, we note in the account of the life-history of the New Zealand reptile Sphenodon, given in the recently published natural history volume on "Amphibia and Reptiles," that the writer has substituted the word "æstivation" for what its discoverer rightly termed a hibernation. Is it possible that he has temporarily confused the southern summer with our own?

Of the illustrations, it may be said that figs. 266, 289 and 299 are examples which are poor, and might well be replaced; the statement that of the 32,000 "known species of Vertebrata" some 10,000 are Teleostei is surely excessive.

MATHEMATICAL TEXT-BOOKS IN THE UNITED STATES.

College Algebra. By J. H. Boyd, Ph.D. Pp. xxii+788. (Chicago: Scott, Foresman and Co., 1901.)

WE cannot obtain a complete view of the state of mathematical studies in a country merely by examining the text-books and treatises which are in vogue there; but we do, in this way, gain a good deal of information about the aims and standards of its mathematical teachers. Dr. Boyd's treatise illustrates very well the qualities and defects of American methods, and suggests a few general remarks, as well as particular criticisms, which may not be out of place.

First of all, it must be acknowledged that the excellences of the better class of mathematical authors in the United States greatly outweigh their deficiencies. The American student is alert and inquisitive; he is neither impervious to new ideas, nor unwilling to make experiments. Moreover, teachers and students alike regard mathematics in the proper spirit—as a science which has, indeed, a venerable history, but is at the same time living and progressive, with ever new developments and ever fresh applications to the needs of man. Many, if not most, of the leading mathematicians in the States have studied in Germany, and have thus become acquainted with the work of Kronecker and Weierstrass and the far-reaching influence of this upon function-theory and the foundations of analysis. In elementary geometry, too, they are not the slaves of tradition, as we are; and it is not impossible that they may ultimately give us the ideal class-book in geometry for which we are waiting.

Dr. Boyd, in his preface, accepts the modern standard of rigour, and in his choice of topics combines the indispensable rudiments with those developments and applications which are really important. The general scope of his book may be indicated by saying that Book I. deals with the fundamental laws of operation; II. with equations of the first degree; III. with indices, surds and complex quantities; IV. with quadratic equations; V. with proportion, progressions and logarithms; VI. with induction, permutations and combinations, and the binomial expansion for a positive integral exponent; VII. with limits and series; VIII. with the properties of determinants and the elementary theory of equations.

After proving the fundamental laws of operation for the cases where they are arithmetically intelligible, the author extends them by purely formal definitions; thus $(a-b)$ is defined by the formal equivalence $(a-b)+b=a$. This is unobjectionable, but seems to us to require more justification than Dr. Boyd explicitly gives. He appeals to the "principle of permanence of form," but this "principle" remains practically an assumption. No doubt it would be extremely tedious to give (what we think has never been done) a complete logical proof that the application of the generalised laws of operation never involves an inconsistency; still, something more might have been done to help the reader to apprehend the reasonableness of the assumption.

Again, Dr. Boyd is not always consistent with himself. Thus, in the chapter on fractions, he begins with the formal definition $\frac{a}{b}\times b=a$; he subsequently says that

4/7 means that a group of 7 things is regarded as a unit group out of which 4 things are taken; and finally gives a proof of the equivalence of 4/7 and 12/21 by means of a graduated scale. This is mixing up three different ways of looking at the matter in a fashion which is very likely to cause confusion. And, so far as his "group" definition goes, he gives it in an imperfect form which is not immediately applicable to improper fractions and which fails to account for the equivalence of a pair such as 4/7 and 12/21.

Another chapter to which we naturally turn is that on irrational numbers and limits. Irrational numbers are treated, after Cantor, as the limits of sequences; and the discussion is satisfactory so far as it goes, though it might well be made rather more complete and is occasionally rather illogical. Thus, for instance, in the early part of the chapter it is said that the ordinary rule for finding a square root, when applied to 2, leads to the inequalities

$$1<\sqrt{2}<2, \quad 1\cdot4<\sqrt{2}<1\cdot5, \quad 1\cdot41<\sqrt{2}<1\cdot42,$$

and so on. As thus stated, the proposition is a pure *petitio principii*. The sequence $(1, 1\cdot4, 1\cdot41, \ldots)$ is convergent, and may be rationally combined with other such sequences according to Cantor's rules; therefore it may be regarded as a number. By definition

$$(1, 1\cdot4, 1\cdot41, \ldots)^2=(1^2, 1\cdot4^2, 1\cdot41^2, \ldots),$$

and this sequence can be proved to be equivalent to 2; therefore $\sqrt{2}$ is an appropriate symbol for $(1, 1\cdot4, 1\cdot41, \ldots)$. We must not begin by assuming the existence of $\sqrt{2}$ as an arithmetical quantity. The proof that sequences obey the laws of operation is put very briefly, and when we turn to the chapter on surds, we find that such an equivalence as $\sqrt{2}\,.\,\sqrt{3}=\sqrt{6}$ is justified, not by the use of sequences, but by a reference to the purely formal law of indices. Here, again, we have a rather unfortunate association of two entirely different notions. If, for any purpose, we like to introduce a symbol θ such that $\theta^2=2$, every rational function of θ can be reduced, by formal processes, to the shape $P+Q\theta$, where P and Q are independent of θ; this is quite independent of the question whether θ can be properly regarded as a number or not; still less does it assign to θ its place in the arithmetical continuum.

Dr. Boyd's chapter on the binomial theorem for any exponent deserves attention, because, although it requires supplementing, it is novel, at least in a text-book, and may prove to be a good way of explaining the theorem to the college student. Let p/q be a positive rational fraction; then

$$(1+x)^{p/q}=\sqrt[q]{(1+px+\tfrac{1}{2}p(p-1)x^2+\ldots+x^p)}.$$

Now it can be shown, as Dr. Boyd indicates without going into detail, that we can, by a process which is, in fact, Horner's method, determine a polynomial

$$y=1+\frac{p}{q}x+c_2x^2+c_3x^3+\ldots+c_mx^m,$$

such that

$$(1+x)^p-y^q=R=Ax^{m+1}+Bx^{m+2}+\ldots+Lx^{qm},$$

where m is any positive integer assigned beforehand. The coefficients c_2, c_3, &c., are numerical, and it can be proved by the method of undetermined coefficients that

$$c_2=\tfrac{1}{2}p(p-q)/q^2, \ldots c_r=\left(\frac{p}{q}-r+1\right)c_{r-1}/r,$$

for $1<r<m+1$. By making m an indefinitely large integer, y becomes an infinite series, which is convergent for $|x|<1$. It remains to be proved that the sum of the infinite series y, when convergent, represents that branch of the function $(1+x)^{p/q}$ which reduces to 1 when x is zero. This last part of the proof Dr. Boyd has failed to supply or even to indicate; the need of it will be seen when it is observed that when y becomes an infinite series, the remainder R is also an infinite series, and it is essential to prove that, as m increases indefinitely, the limit of R is zero.

It will not be amiss to observe that these criticisms, offered with all friendliness and sympathy, are provoked just *because* Dr. Boyd aims at a high standard of logical exactitude. Many a worse book than his may be said to have fewer faults—faults, that is, which lie on the surface and can be pointed out in a few words. To write a really sound book on algebra, not incomprehensible to the ordinary college student, and not hopelessly unscientific when judged from the standpoint of contemporary analysis, is a very difficult task. But it is a worthy one; and the attempt justifies itself, even if it is not crowned with unqualified success. The reader of Dr. Boyd's book cannot fail to gain many fruitful ideas; if he has mathematical capacity he will very likely apprehend them in a substantially correct form, even when the author's exposition is not entirely rigorous.

To sum up, we find in this treatise, as in others of its class, much that is fresh, vital and stimulating; an interest in the progress of research, and in the development of new conceptions; together with a style that is neither frivolous nor pedantic. What we miss is, on the one hand, the German thoroughness which spares no pains to make the logical chain of an argument complete, and, on the other, our English dexterity of manipulation. This last faculty is not of much importance, truly, but is worth reasonable cultivation. It is strange to us, for instance, to find a whole page spent on the decomposition of x^4+px^2+q into a product $(x^2+\alpha)(x^2+\beta)$ without any reference to the fact that x^4+px^2+q is a quadratic in x^2. It is only fair to say that, in this instance, the context partly accounts for the phenomenon; but other examples of needlessly complicated work could easily be given.

G. B. M.

A CANADIAN PIONEER IN SCIENCE AND EDUCATION.

Fifty Years of Work in Canada, Scientific and Educational. By Sir William Dawson, C.M.G., LL.D., F.R.S. Pp. viii + 308. (London and Edinburgh: Ballantyne, 1901.)

LITTLE more than a year has passed since the friends of science and of education in Canada had to mourn the death of Sir William Dawson. Though for the last six years of his life he had retired from his active official duties, his pen was not allowed to remain idle, but continued to throw off papers for scientific journals, addresses to societies and books of a more or less popular kind. One of the occupations of these closing years appears to have been the preparation of a sketch of his own career, which he left complete even to the dated preface

with instructions to his son to have it published as early as might be practicable after his death. Dr. Rankine Dawson has accordingly fulfilled the charge committed to him, and the result is a little volume entitled "Fifty years of Work in Canada, Scientific and Educational."

To those who were privileged with Sir William's friendship or acquaintance, the autobiography will recall many of the traits of his character, many little touches of manner and expression, and many of the moods of thought which showed themselves in his familiar talk. But to those who knew him not, the book will hardly reveal what manner of man he really was. Its readers will learn from it, indeed, that he must have been an enthusiastic student of nature, an upright and earnest and indefatigable teacher, an evidently kindly and genial man who with infinite patience and perseverance, and obviously with consummate tact and skill, fought and won the battle of higher education, for women as well as for men, in a colony where everything had to be begun from the beginning, and where the hindrances and opposition might have daunted a braver pioneer. It traces his life in outline from his boyhood at Pictou in Nova Scotia to his final retirement in the cottage at Little Métis, where, after a slight paralytic seizure in 1897, he quietly waited for the end. But it is no more than an outline, and though interesting as being his own account of himself, it is scarcely adequate as a lasting and final memorial of one who well deserves to be had in remembrance for his services to the geology and educational progress of Canada. Having been delayed till almost the end of his life, the autobiography lacks the freshness and fulness of recent recollection. Sir William met with many interesting and notable men in his time of whom one would fain have had his impressions—such pen-portraits as he probably gave in letters to his friends or family. One would like to know something more of his boyhood and the influences that drew him into the geological field. In a new country, before the days of railroads and coasting steamers, geological expeditions must often have brought a man into strange experiences. Then in regard to educational effort, which lay so close to Sir William's heart and to which he devoted so large a part of his strenuous life, he gives just information enough to make us long for more, that would fill in the details of an interesting struggle of which merely a sketch is given in the book. His published addresses and reports enable us to trace the general progress of his efforts, but naturally they lack the personal element, and the ordinary reader may sometimes fail to realise how much of the advance they chronicle was due to the initiation and persistent energy of the principal of McGill College himself.

Sir William Dawson's original contributions to science range over a considerable field, but the most important of them deal mainly with two departments of geology. He has done more than any other writer to make known the characters and the richness of the vegetation that preceded the luxuriant flora of the Carboniferous period. He speaks regretfully of the refusal of the council of our Royal Society to publish a paper and illustrations which he had prepared on the plants of the Old Red Sandstone, "thereby losing the credit of giving to the world the largest contribution made in our time to the flora of the period before the Carboniferous age." He adds that "a work which had cost me a large amount of time, labour and expense, and which I had looked upon as my *magnum opus*, was not adequately published and probably never will be."

The other branch of geological inquiry which Sir William prosecuted with characteristic energy related to the glacial deposits of Canada. After publishing a series of papers on the subject, he gathered up his results in more connected and popular form and published them in 1894 in his volume on "The Canadian Ice-Age." While glacialists have not generally accepted some of his views of the succession of events, they must acknowledge that recognition is due to the pioneer work by which the facts were first collected and arranged.

Allusion may be made here to another scientific question to which Dawson devoted a great deal of time and thought, though comparatively little reference to the subject occurs in the present volume. His name will always be associated with those of Logan and Carpenter in connection with the *Eozoon Canadense* of the Laurentian limestone. They regarded it as the earliest known trace of animal life, and as probably belonging to the foraminifera. Eventually their views were criticised and opposed, until now the prevailing opinion is adverse to the organic grade of the supposed fossil, but the principal of McGill College appears to have maintained his position to the end.

Sir William Dawson was an eminently religious man and a Christian of the most orthodox Presbyterian type. Though naturally peaceful, he was always ready to lay lance in rest and have a tilt with some adversary of his faith. He never accepted Darwinism. Three months after the appearance of the "Origin of Species" he published his first criticism of the modern doctrine of evolution. From that time, in articles, addresses and books, he continued to express more or less forcibly his dissent. The year before his death he summed up "The Case against Evolution," and in the autobiography which occupied his last days there are occasional indications of his unabated opposition to the opinions "as to the great instability of species, which have been so current among the leaders of the Darwinian evolution." His more popular volumes have had a wide circulation and have been of service in spreading an interest in geology and geological speculation.

The autobiography indicates in general terms that its author led a busy life, but no reader will gather from it an adequate idea of the extraordinary activity of that life. Even the ample list of separate papers which appears in the Catalogue of the Royal Society indicates only one side of his work. To that list must be added a voluminous series of lectures and papers on a wide range of educational, theological and other subjects, and quite a small library of separate books. And all this literary industry went on amid the incessant calls of an onerous official position. We trust that the autobiography may soon reach a second edition, and that advantage will then be taken of the opportunity to add such information as will hand down a fuller picture of the life and work of the late principal. A selection from his letters would be a welcome addition to the volume, likewise a list of his publications arranged year by year. Such a list, prepared by Dr. H. M. Ami, one of Dawson's pupils and a member

of the staff of the Geological Survey of Canada, was published in *The American Geologist* for July 1900. It needs careful revision, but might be made the foundation of a good bibliography. Sir William took so prominent a place in his time that there must be many hundreds of his friends and pupils who, while delighted to have his autobiographical sketch, would be glad to possess a fuller memorial of the man and of his achievements in the cause of science and of education. A. G.

THE FLORA OF INDIA ILLUSTRATED.

Annals of the Royal Botanic Garden, Calcutta. Vol. ix. Part i. *A Second Century of New and Rare Indian Plants.* (Calcutta: 1901.)

WITH the exception, perhaps, of Brazil, the flora of which has been more systematically illustrated, the flora of no country of very large area is so well pictorially illustrated as that of India. Disregarding the earlier publications of less precision, there are the works of Wight, Wallich, Roxburgh, Griffith, Royle and Hooker, and, later, of Brandis, Beddome and others, to say nothing of the very numerous scattered figures of Indian plants.

In 1888 Dr. (now Sir George) King, then Superintendent of the Calcutta Botanic Garden, commenced publishing a new series of quarto illustrations of Indian plants under the title cited above. The first volume contains all the Indian species of Ficus; the second the species of Artocarpus, Quercus and Castanopsis; both by King himself. The third volume is an illustrated monograph of the Indian species of the herbaceous genus Pedicularis, by Dr. D. Prain, the present Superintendent of the Calcutta Garden. The fourth volume is devoted to the Anonaceæ, by King; and the fifth contains a century of orchids, edited by Sir Joseph Hooker, and a century of new and rare Indian plants, by King and P. Brühl. The sixth volume is of a different character, and illustrates some of the microscopic researches of Dr. D. D. Cunningham. The seventh is a fully illustrated monograph of the Bambuseæ of India, by Mr. J. S. Gamble. The eighth volume, nominally, consists really of three thick volumes and comprises 448 coloured plates of Indian orchids, by Sir George King and Mr. R. Pantling. Each of these volumes has been more or less fully noticed in NATURE as it appeared.

The first part of the ninth volume contains a second century of new and rare Indian plants, by King and Prain and Mr. J. F. Duthie, Director of the Botanical Department, Northern India. Remarkable among these novelties are five beautiful species of Meconopsis (Papaveraceæ), thus nearly doubling the number of this essentially Himalayan genus. The specific names, *grandis*, *superba*, *bella* and *primulina*, are suggestive of the ornamental characters which these herbaceous plants possess in a high degree. Unfortunately they are rather difficult to cultivate, but one or two species succeed very well in the rock-garden at Kew. Two or three very fine species of Meconopsis are among the comparatively recent discoveries in western China, and *M. horridula* is one of the most generally dispersed plants in the meagre flora of Tibet, at altitudes of 12,000 to 17,000 feet. Indeed, all the Asiatic species inhabit high levels, and some of them reach the upper limit of phanerogamic vegetation. The only outliers of the genus are *M. Cambrica*, the lowly Welsh poppy, and *M. heterophylla*, a native of California. One of the finest of the species figured in the "Annals," *M. grandis*, is only known from Jongri, in Sikkim, where it is cultivated at altitudes of 10,000 to 12,000 feet, not for its beauty, however, but for the oil obtained from its seeds. Figures are given of three other pretty Papaveraceæ, namely, *Cathcartia lyrata*, *C. polygonoides* and *Chelidonium Dicranostigma*.

From a botanical standpoint the drawings are very good, and the lithography deserves to be rated as excellent. Nearly the whole is the work of native artists.

We have made a point of the new Papaveraceæ, but there are other equally interesting subjects illustrated in this part. New Rutaceæ, Burseraceæ and Sapindaceæ, chiefly by King; Leguminosæ and Labiatæ, by Prain; and alpine Himalayan plants, including new species of Primula, by Duthie.

There is also a proposed new genus of Orobanchaceæ, concerning which particulars of its affinities might have been given. It is named *Gleadovia ruborum*, and was discovered by Messrs. Gleadow and Gamble growing on the roots of *Rubus niveus*, in fir woods, in the North-west Himalaya. The great value of such a publication as the "Annals" can only be appreciated by the working botanist, and it will be of general interest to know that plants of special economic interest will be a feature in the next part. W. BOTTING HEMSLEY.

OUR BOOK SHELF.

Essais sur la Philosophie des Sciences. Analyse, Mécanique. By C. de Freycinet. Second edition. Pp. xiii + 336. (Paris: Gauthier Villars, 1900.)

A GOOD book on the philosophical aspect of space, time, mass and force is rare. M. de Freycinet has produced a work that is both readable and worth reading. It opens with a chapter on space and time in which the essential differences of these two fundamental conceptions are discussed, and the impossibility of forming a quantitative estimate of time except by artificial means is clearly pointed out. The next chapters deal with the notions of infinity, of continuous magnitude, of limits, of infinitesimals and of differential coefficients. In considering the reality of such conceptions, the author is careful to distinguish between reality in a mathematical and in a physical sense, and to point out that reality in the first sense does not necessarily imply reality in the second. Thus the solutions by the calculus of many problems in mathematical physics are based on the assumption that both space and matter are continuous and capable of indefinite subdivision, and these solutions are none the less correct although other phenomena teach us that matter is to be regarded as built up of discrete molecules.

The second part deals with the quantities occurring in dynamics, the laws of motion, the principle of conservation of energy. In it M. de Freycinet has endeavoured in the present second edition to throw greater light on the debated question as to the relative parts played by Galileo and Kepler in the discovery of the laws of motion. According to him these laws consist of (1) the law of equality of action and reaction, due to Newton; (2) the law of inertia, now attributed to Kepler; (3) the law of independence of movements due to Galileo, according to which the relative motion of the parts of a system is unaltered by impressing a common velocity on them; and (4) the law of equivalence of work and heat due to Mayer

and Joule. If this last law, which practically amounts to a definition of *heat* as a dynamical quantity, coupled with a statement of the principle of conservation of energy, is to be admitted among the laws of motion, why should the second law of thermodynamics be excluded? In chapter vii. the author discusses the possible causes of loss of energy in the universe, but he might with considerable advantage introduce something about the degradation of available energy. This principle has an important bearing on the question of the infinity of the universe and the infinity of time. A finite universe cannot have existed for an infinite time past, radiating its energy into infinite space, but as soon as the principle of degradation of available energy is assumed, a similar difficulty as to infinity of time is found in dealing with an infinite universe, all of whose energy ultimately tends to be dissipated in the form of heat, and all of whose parts tend to a common temperature.

There is thus ample room for M. de Freycinet to write a further essay on the irreversible phenomena of Nature. There is another interesting field of study which he now mentions only in a footnote on p. 43, namely the existence of imaginary quantity and the remarkable fact that the generalisation of the laws of ordinary algebra requires the introduction of only one imaginary symbol. But, as the author points out, in the present state of science it is impossible for one man to survey our knowledge of more than a limited portion of natural phenomena. M. de Freycinet has given his readers much to think about in the domains of infinitesimal analysis and rational mechanics, and, moreover, this is written in a style which makes the book easy to read.

The Thermal Measurement of Energy. Lectures delivered at the Philosophical Hall, Leeds, by E. H. Griffiths, M.A., F.R.S. Pp. viii+133. (Cambridge: University Press, 1901.)

THIS little book consists of an account of four lectures, delivered to teachers by the author, at the request of the Technical Instruction Committee of the West Riding County Council. The author remarks that "The reflection that hundreds of such teachers should have been willing to sacrifice their Saturday afternoons to the study of certain physical measurements which did not even possess the charm of novelty may somewhat lighten the gloomy prospect sketched for us by those who hold pessimistic views as to the future of Intermediate Scientific Education in this country."

In attempting to render interesting a discussion of the thermal measurement of energy, Mr. Griffiths undertook a difficult task, which he has discharged admirably. There is no trace of the "popular lecturer" pure and simple; in his treatment of the subject success is due, not to an adroit avoidance of difficulties, but to the straightforward and conscientious attention given to every point of importance. In the first lecture, a number of well-chosen experiments are used to illustrate the conversion of work into heat. The second lecture is occupied with a consideration of the first and second laws of thermodynamics; incidentally the student is made acquainted with some of the difficulties attending thermometric determinations. In the third lecture an account is given of the principal methods which have been employed to determine the mechanical equivalent of heat. In this connection students will welcome the description of Reynolds and Moorby's determination, which has not as yet been dealt with in the text-books; it is to be regretted that more space could not be devoted to this valuable piece of work. A good account is given of Mr. Griffiths' own experimental test of the validity of the system of electrical units. Lecture iii. closes with a description of the recent experimental work of Callendar and Barnes on the variation in the specific heat of water.

The fourth lecture possesses very great interest. After remarking that text-books frequently give the specific heats of the metals to four of five decimal places, it is pointed out that these results necessarily depend for their accuracy on the values assumed for the specific heat of water at various temperatures. Generally speaking, authors content themselves with referring to Regnault's results, without, however, consulting Regnault's original papers. It appears that *only two* experiments were performed by Regnault for temperatures below 107°, and these were undertaken merely to test the working of the apparatus used, and Regnault himself attached no importance to them. As a matter of fact, Regnault performed a series of determinations of the changes in the specific heat of water *over the range* 107° *to* 190° C. After discussing the results, he stated what the nature of the variation between 0° and 100° would be if deduced by extrapolation from the experimental curve obtained at the higher range. Later investigations have proved these conclusions to be at fault, so that much otherwise unimpeachable experimental work relating to specific heats requires revision, and in many cases the data necessary for this purpose are not given by the authors.

It is finally recommended that the specific heat of water between 17° and 18° C. shall be defined as of unit value; this also amounts to defining the mean specific heat of water between 0° and 100° as of unit value. In that case the most probable value of the mechanical equivalent of heat is equal to $41 \cdot 84 \times 10^6$. E. E.

Instruments et Méthodes de Mesures Electriques Industrielles. By H. Armagnat. Pp. iii+614. (Paris: C. Naud.)

FEW, perhaps, realise how much electrical engineering owes its rapid development to the ease and precision with which the measurements it needs can be made. Yet it is this which renders it so amenable to mathematical and scientific treatment, and it is very largely owing to the fact that it can be so treated that it has progressed so rapidly. The manufacture of instruments has in many instances led rather than followed the development of the engineering side of the electrical industry. The practical engineer finds ready to his hand instruments for almost every conceivable purpose he may require, and it cannot be questioned that it is of the highest importance that he should properly understand their construction and limitations. M. Armagnat's book should therefore prove exceedingly useful to such men as a work of reference in which they can find a full discussion of the principles underlying the construction of the tools they use. As the author points out in his preface, beginners, and those also who habitually use instruments, are too often ignorant of their powers and of the proper way of treating them. Many mistakes, often of a serious nature, would be avoided if this state of affairs were remedied.

M. Armagnat describes both the instruments which are only to be found in electrical laboratories and those which are in daily and extended commercial use. It is the part of the book dealing with the commercial instruments which will commend itself more particularly to the practical engineer. The author has wisely confined himself to describing typical instruments of each class, and has refrained from giving descriptions of the numerous different examples of the type. Perhaps, however, an improvement would be introduced if instruments of different makes were compared, as this would serve as a useful guide to those who are in doubt as to what to purchase most suitable for their particular requirements. Valuable information is given as to the best methods of installing delicate instruments, of securing good illumination, freedom from vibration and outside disturbance, and of carrying out observations and measurements. The chapters devoted to these subjects add very greatly to the usefulness of the book, especially from the point of

view of the student. It may be said finally that the book is not merely useful as a work of reference, but it is thoroughly readable throughout. M. S.

Pleasures of the Telescope. By Garrett P. Serviss. Pp. vi + 200. (London: Hirschfeld Brothers, 1901.) Price 6*s*. net.

THIS book is the result of the collection under one cover of a series of articles originally published in serial form, after considerable revision and insertion of matter necessary to bring the information up to date.

Chapter i. deals in a very interesting manner with advice on the choice of telescopes, special characteristics of refractors and reflectors, principles underlying the achromatic corrections of refractors, and methods of testing the performance of astronomical instruments.

Following this, six chapters are devoted to a series of descriptions of the constellations, numerical particulars being furnished for all the more interesting objects. A very liberal supply of star-maps—twenty-six—serves for the identification of all the objects mentioned in the text.

The main features of the planets are also described, small cuts indicating the details to be seen with powers usually at an amateur's command. Four charts of the moon are given, showing the more important formations only, so as to avoid the confusion inseparable from the complete maps. This section is made exceedingly interesting by the various formations being compared with each other, the reader passing from one to another much more readily than by merely going over a list of objects. Users of the book will recognise the treatment of the subject as similar to that in "Astronomy with an Opera-glass," by the same author, and it will doubtless be welcome to many workers who only require information concerning objects within reach of the instruments usually possessed by amateurs; but the size of telescope catered for, of 5 inches aperture, is sufficiently large to render the information of service to the more advanced astronomer as well. There is only one slight criticism which may be suggested regarding the preparation of the star maps. On these there is no indication of either the coordinates of right ascension or declination. In actual practice, either in learning the constellations or in passing from one map to another, it is impossible to over-estimate the help which is furnished by the graduated position lines. The legibility and general arrangement of the maps, however, are excellent and add greatly to the value of the book, which there can be no hesitation in recommending to the notice of all interested in observational astronomy. C. P. B.

Introductory Physics for Irish Intermediate Schools. By R. A. Gregory and A. T. Simmons, B.Sc. Pp. ix + 218. (London: Macmillan and Co., Ltd., 1901.) Price 2*s*.

THIS little book, as its emerald-green covers and title suggest, is for the use of Irish boys and girls preparing for the examination on the new syllabus in introductory physics issued by the Department of Agriculture and Technical Instruction. A glance at the book shows that Irish physics is the same as English, and those familiar with the other books prepared by the same authors will find here practically the same exercises. S. S.

Algebraical Examples. By H. S. Hall, M.A. Pp. viii + 172. (London: Macmillan and Co., Ltd.) Price 2*s*.

IT will be a convenience to many teachers to possess this collection of algebraical exercises to supplement those given in Hall and Knight's "Algebra for Beginners" and "Elementary Algebra," up to quadratic equations. The exercises are carefully graduated, and are classified so that the teacher can easily select those referring to the subject with which he is dealing. In addition, there are a number of test-papers containing miscellaneous examples to test the pupil's grasp of the principles of algebra in which he has been exercised.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

The FitzGerald-Lorentz Effect.

IN the January number of the *Philosophical Magazine* I published a discussion of the general theory underlying the experiment of Messrs. Michelson and Morley on the drift of the æther. As one result, it appeared that the effect to be expected in their special case was just the opposite of that usually supposed, and that consequently the FitzGerald-Lorentz explanation of the observed null effect would not hold. Mr. H. M. Macdonald has pointed out the source of this discrepancy in an algebraic slip in my paper; when this is corrected, the result comes into agreement with the special case treated by Michelson and Morley. The exact effect on the displacement of the interference-bands arising from a vertical component in the æther-drift has not been hitherto directly considered. It is probably null; but this requires verification, which I hope to be able to take up shortly on the basis of my analysis. As the question stands at present, the corrected result shows that the FitzGerald-Lorentz shrinkage would completely annul the shift when the drift is tangential. Although Dr. Larmor has not directly discussed the effect of an oblique drift in his "Aether and Matter," I understand from him that he has come to the conclusion (*cf. loc. cit.* § 34) that complete annulment results in all cases on the FitzGerald-Lorentz hypothesis. I think further discussion on the lines of my own method of analysis will verify that this is the case.

Meantime I send this intimation in order that others may not spend time in tracking out a discrepancy which has already been cleared up. W. M. HICKS.

University College, Sheffield, February 10.

Birds Attacking Butterflies.

ON July 22, 1901, a dull, sunless day, I pointed out to Prof. Gotch a fine fresh male specimen of the "Holly Blue" (*Lycaena argiolus*) at rest on the leaf of a shrub behind the Oxford University Museum. Touching it with my finger, the butterfly rose and fluttered feebly along the curved walk in the Parks. At that moment a swallow (or a martin) came down the walk from the opposite direction at full speed. It must have seen the butterfly fluttering towards it from a considerable distance; for with the most perfect ease and control it diverted its course and took the insect in its sweep. I felt, as I saw it, that only by good fortune was it possible thus to obtain the most direct evidence of events which are probably continually occurring.

There are, however, other means by which evidence can be obtained. One is the examination of the crops of dead birds. Although we should be sorry for British birds to be killed with this object (except in special circumstances), it is much to be hoped that the observations will be made when birds are killed, whether accidentally or otherwise. Mr. R. Newstead, of the Chester Museum, has done excellent work in this way; but there can be no doubt that, taking the country as a whole, only an insignificant proportion of the obtainable evidence is utilised.

Another line of evidence is afforded by specimens of butterflies which have their wings injured in a manner which is inconsistent with any interpretation except the snip of a bird's beak. Thus it is common to find fresh and unworn specimens with a notch or tear on the right side which exactly fits a corresponding injury on the left side, indicating that the wings had been torn when they were in contact. In one extreme instance, presented to the Hope Department by Dr. F. A. Dixey, a deep little notch had been cut out of all four wings of a "Red Admiral" (*Vanessa atalanta*), the four injuries exactly coinciding in the true position of rest adopted by this insect.

Oxford, February 2. EDWARD B. POULTON.

P.S.—Mr. W. Holland, of the Hope Department, tells me that about the middle of June 1901 he saw a swallow swoop down from a great distance and catch a white butterfly (almost certainly *Pieris rapae*) flying in front of the Museum. The bird took the insect in a single sweep and then dextrously avoided a

collision, which seemed almost inevitable, with the roof of the "Glastonbury Kitchen." Directly after the seizure of the butterfly, Mr. Holland saw the wings fluttering to the ground, evidently cut through at their bases by the beak.—E. B. P.

I CAN corroborate the statement that the house-sparrow frequently pursues and captures the large white cabbage butterfly.

Probably the kestrel preys extensively on the emperor moth, whose wings I have seen lying at the base of the small hummocks formed by the *Juncus squarrosus* on the Orkney moorlands. These tufts were much used as resting places by kestrels and hen harriers, but as neither hawk is capable of catching a bird on the wing, the moths were presumably captured while at rest.

The black-headed gull feeds on the common ghost moth. Regularly every season, during many years, I saw some half dozen or more of these gulls flying backwards and forwards, about three feet above the ground, over the grass in front of my house, hawking after the white oscillating ghost moths in the long summer twilight of a calm Orcadian evening.

W. IRVINE FORTESCUE.

7, Bon Accord Square, Aberdeen, February 3.

The Severn Bore.

IN NATURE of January 23 there is an interesting illustration of the Severn Bore, as photographed by Dr. Vaughan Cornish. If I understand the note rightly, the bore took a little more than a minute to travel 500 yards, and this gives a rate of almost exactly seventeen miles an hour at the given locality.

On March 13, 1891, Mr. T. H. Thomas, R.C.A., and I measured the velocity of the bore between a point on the right bank of the river near the King's Head Inn (which is sixty yards north of the sixth milestone from Gloucester on the high road to Newnham) and a point further up on the right bank of the river, near Denny Farm and opposite to the fifth milestone from Gloucester.

The second hands of two watches were timed exactly together, and we found that the bore reached the first observer at 10h. 24m. 45s., a.m., and the second at 10h. 27m. 48s., a.m., the interval being 183 seconds.

Measured on the six-inch ordnance map, the distance along the central line of the river is 4750 feet. The velocity was therefore $17\frac{7}{10}$ miles an hour for the part of the river observed. The river channel there is of a fairly uniform width of 250 feet.

The date chosen was that of the second highest tide of the spring equinox. At 10h. 25m. the height of the bore, above low water level, as measured by a post close to the river bank near the King's Head Inn, was 4ft. 10in. As the bore passed on, the level sank to 3ft. 4in. By 10h. 30m. the water following the bore reached a height of 5ft. 4in. At 10h. $32\frac{1}{2}$m. the height was 6ft. 4in., and at 10h. 34m. the water covered the post, the top of which was nearly 7ft. above low water level. There was thus a rapid rise of the river in the rear of the bore. As seen in mid-stream, the height of the crest of the bore seemed only about 3ft. above that of the water in front of it.

There was a gentle breeze from the north-east. Had there been a south-westerly gale blowing up stream, no doubt the phenomenon wou'd have been much more impressive, but it is of interest to record observations made under fairly normal conditions.

The rushing sound, heralding the advancing wall of water, was audible for some distance. The crest of the bore was whitened by a fringe of foam, and a good deal of spray was thrown up on the banks, where the water of the wave appeared to be higher than, and somewhat in advance of, that in the middle of the river.

A small boat in the path of the bore suffered no inconvenience beyond a slight tossing. The late Frank Buckland greatly exaggerated when he described the bore as "the greatest natural phenomenon in the British Isles," and stated that its pace was equal to that of an express train. Dr. Cornish (NATURE, vol. lxii. p. 127) estimates the velocity of the bore, on April 30, 1900, as eight miles an hour between Newnham Ferry and Denny Farm, a river distance of about nine miles. But the velocity evidently increases as the stream narrows, and, in the short portion which we observed, it will be noticed that the velocity was more than twice that estimated over the longer distance.

CHAS. T. WHITMELL.

Leeds, February 3.

Persistence of the Direction of Hair in Man.

IN "The Descent of Man," p. 19, under the heading of Rudiments, Darwin refers to the long isolated hairs seen in the eyebrows of certain individuals, as representing similar hairs in the superciliary region of the chimpanzee, baboon and certain species of macacus. An analogous phenomenon, with a different significance, found sometimes in the pectoral region in man, seems to be worth notice. I have recently examined two persons, a male aged twenty-eight and a female aged thirty-three years, both with particularly hairless, smooth skins, and each showing, at a critical point in the pectoral region, certain outstanding hairs set closely together, the former three long hairs an inch in length, and the latter two hairs an inch and a half in length. The point of interest lies in the position and direction of these few scattered hairs, which are as noteworthy, in their way, as "erratic blocks" on a level plain. In the female case the two hairs were set just over the middle of the left second costal cartilage, and they pointed persistently *upwards* towards the neck. In the male case the three long hairs were set close to the sternum in the left second intercostal space pointing persistently *downwards*. The situations of these two curious islets of hair are exactly above, on the one hand, and below, on the other, the level at which the upward chest-stream and the downward chest-stream always divide in a hairy subject. The remarkable persistence in their ancestral direction of these few "fossil" hairs, as they might be called, seems to confirm the view that if man has inherited his hairy covering from a simian ancestry it has been modified in many regions by use and habit since he inherited it. We say that a little straw shows the way in which the wind blows, and I submit that sundry stray hairs on the body of man similarly testify as to the trend of certain mechanical forces which have acted and still act upon him.

WALTER KIDD.

The Colours of Wings of Butterflies.

MR. CROFT'S letter (NATURE, January 2, p. 198) on the subject of colours of wings of butterflies raises an interesting point.

In pressing the wings of butterflies between sheets of gummed paper in order to obtain impressions for record, I have frequently noticed that in those cases where a brilliant light blue wing is to be pressed the impression usually fails to give the correct colour; in transmitted light the impression is not blue, and in reflected light the colour is patchy and of a much darker blue; for example, the blue of a *Junonia erithyia.*

I have before me a wing—inside brilliant peacock blue, purple-blue, bronze-brown, according to the incidence of the light; in transmitted light the colour is brown. The outside of the wing is brown.

Taking an impression of this wing in transmitted light the impression is brown, in incident light very dark blue and dark bronze in patches; the peacock blue fails entirely.

If a scale of this wing be examined under a low power it appears brown in transmitted light, but peacock blue (and varying shades according to position of scale on stage with reference to light) if the transmitted light be cut off and reflected light alone used.

It would appear, therefore, that this wing owed its chief colours to other causes than pigment.

W. G. B.

India, January 21.

EXPERIMENTS ON VENTILATING COWLS.[1]

THE report of the work of the cowl committee of the Sanitary Institute presents the results of the numerous experiments made by the committee in the course of upwards of twenty years of its existence—an existence unfortunately terminated by the deaths in rapid succession of all its members. The last survivor, Mr. Rogers Field, B.A., M.Inst.C.E, the most active member of the Committee, died on March 28, 1900.

The committee left in manuscript more or less complete records of some seven thousand experiments on cowls and terminals, together with particulars of the arrangements for testing the instruments employed, a synopsis prepared with a view to a comprehensive report, and

[1] The Work of the Cowl Committee of the Sanitary Institute. *Journal of the Sanitary Institute.* (Edward Stanford, 1901.)

some materials for a historical introduction, but practically no actual text. The council of the Sanitary Institute did me the honour of asking me to undertake the preparation of the report. For obvious reasons, the part that I could take in such an enterprise could only be a small one; it was limited to supervising the work done by two of Mr. Rogers Field's assistants and writing an occasional general note. In doing so I have regarded the report as addressed to those interested in the scientific study of pneumatics, and have not hesitated to call attention to the points in which the action of the committee seemed to me to have missed the true scientific bearings of its work. I propose to be equally frank in what I have now to say, but I would not thereby be understood as decrying the accuracy or the value of the experiments. The study of pneumatics has remained undeveloped probably more on account of the lack of accurate experiments and accurate measuring instruments than for any other reason. The records of the cowl committee bear ample testimony to the singleness of purpose of the committee in its desire to take all precautions and bring all conclusions to the test of accurate experiment, and the records of the experiments, with the limits of accuracy clearly apparent, must always be regarded as valuable data by which to test theoretical conclusions and an honourable memorial of a worthy effort to enlarge our knowledge of a most intricate subject.

The object of the committee was to compare, by direct experiment, cowls of different type as agents for producing a flow of air when exposed to wind and for preventing downdraught. The procedure adopted was to have three long vertical tubes projecting from a weather-boarded hut, erected, by permission of the Kew Observatory committee, in the Old Deer Park at Richmond. Each tube had an air meter inserted in it to measure the flow of air; the lower end was protected from draughts by a box with a silk gauze bottom; an anemometer gave the velocity of the wind, the direction of which was also recorded. The cowl was mounted on the middle of the three pipes, and the flow through that pipe was referred to the mean of the flow through the two external pipes. The tests of downdraught were of various descriptions that need not be referred to here.

With the comparison of cowls of recognised shapes there was associated an endeavour to ascertain the effect of different modifications of the orifice of a pipe, and for this purpose a number of such modifications were constructed and examined. Such modifications, some of which were very elaborate, are called terminals.

The report is divided into six parts:—

Part i. consists of extracts from introductory papers prepared by various members of the committee or from the correspondence preserved by the committee.

Part ii. contains an account of the testing of the air meters, and will be found to give a considerable amount of information of very great practical utility concerning the action of those instruments.

Part iii. gives the results of Mr. Rogers Field's investigation of the action of the anemometers employed. The instruments principally considered are a Robinson anemometer of the standard Kew pattern and a miniature instrument of the same type with one-inch cups. The chapter does not add much to the solution of the general problem of determining true wind velocity from the reading of a Robinson instrument, but it does show what kind of difficulties a careful and conscientious experimenter is likely to meet with if he sets about using such an instrument for the determination of true wind velocity. It also shows by some very useful diagrams the relation between the wind velocity and the flow up a vertical open tube over the end of which the wind passes.

Part iv. gives an examination of the degree of accuracy with which the mean of the flow in two outside pipes can be regarded as equivalent to the flow up the middle pipe. In some ways the results of this section are the least interesting of the whole number, because the observed differences which the committee attemped to resolve must be regarded as due to local circumstances which would probably not be reproduced in a repetition of the experiments under somewhat different conditions; but they are an essential part of the work of the committee; they show the limits of accuracy of the measurements under the prescribed conditions. Probably an experimenter with long experience of a laboratory might have been content to recognise after a few experiments a certain margin of experimental error as incidental to the method, and have left the cowl results with that margin of error, or have selected conditions which gave the least experimental differences; but the committee seemed unwilling to write off an experiment as subject to a certain margin of error until it had fully probed all the causes of error.

Part v. gives the results for terminals, as defined above. The results which can best be generalised are those which are represented in the report by what are known as "hill curves," by which are to be understood curves representing results obtained from a series of consecutive experiments upon terminals varying by the gradual extension of some particular dimension.

Part vi. gives the results for cowls.

A consideration of the whole report gives rise at once to curious reflections. If an apostle of higher education were looking for an example of the importance of recondite theoretical study to matters of practice, of the necessity to practical life for the academic professor in any subject, not as an exponent of the facts of the subject, but as a student and investigator of its abstract laws, he could not wish for a better example than that furnished by this report.

The original committee was appointed to settle an apparently simple practical matter, namely, which was the best among a number of cowls exhibited at Leamington in 1876 in competition for a prize or certificate. The matter was apparently confined to the region of practice, and it was at first assumed that only a few experiments were needed to settle the points in question. Experiments were made, and the committee reported to the effect that no cowl at all was as good as any; and the award went in consequence to no cowl at all. But this did not by any means satisfy all concerned, and numerous complaints were made as to the experiments and the way of conducting them.

Thereupon the Sanitary Institute appointed Sir Douglas Galton, Mr. Rogers Field and Mr. W. Eassie—the last-mentioned was subsequently succeeded by Mr. J. Wallace Peggs—to be a committee to conduct further experiments. They set out to repeat the experiments with such precautions that their results should be accepted as final. They worked with unremitting labour and at no small expense; tested to the uttermost every instrument employed in the investigation, and analysed all the conditions that might affect the results. They acted throughout upon the apparently simple practical principle that they could find out which was the best cowl if they could find out, for a certain strength of wind, which carried most air up a three-inch or a six-inch pipe, and up to what angle of tilt it could be set in various circumstances without suffering downdraught.

It certainly cannot be regarded as a fault in the committee that the subject had not been effectively worked at by some academic professor or student of experimental philosophy curious to learn, not which cowl should have a prize, but the general laws of flow of air through any cowl. They were capable, practical men, and naturally attempted a direct experimental answer. It may be true that in nine cases out of ten the best way of getting a practical answer to a scientific question is to set practical men to find it,

and that a professor of natural philosophy would spend a long time over the inquiry and return an unpractical answer. The problem attacked by the cowl committee happened to be the exceptional tenth case in which, not academic students, but practical men, spent twenty years, a period, indeed, terminated only by the deaths of the members of the committee, without arriving at practical results of the final character looked for.

As a matter of fact, the flow of air along a three-inch or six-inch tube surmounted by a cowl is a very complicated result; it is no more and no less the measure of the efficiency of the cowl on the top of the pipe than the current through a galvanometer is a measure of the efficiency of a battery cell in circuit with it. If we picture to ourselves a committee endeavouring to pronounce upon the relative merits of the battery cells of many inventors by tabulating the deflections which they produce in a galvanometer before G. S. Ohm had been led, by purely scientific researches, to the law which has been the guide in all such questions since his time, we get an exact analogy of the action of the cowl committee. Before the efficiency of the best cowl can be effectively represented by a number, it is desirable to settle what purpose the instrument is intended to serve. The production of a flow of air in a particular combination of tubes is doubtless one purpose, but there are others. Some cowls are intended to keep the rain out of a shaft; some are picturesque terminations of flues, as the Italian examples cited by Mr. Ackermann in the cowl report; all, presumably, are intended to bring profit to their makers. As regards efficiency, they might be classified according to their performance with regard to one or other of these widely different purposes, but the classification would not be strictly scientific.

To the student of theoretical science they can only be regarded as examples of apparatus for diverting the kinetic energy of the passing air to produce a flow along the pipe which the cowl surmounts, whether the flow be up or down; and the laws of transformation of the energy will most effectively describe the behaviour of the cowls from the scientific point of view. The flow along the pipe implies a certain expenditure of energy which must ultimately be derived from the passing air (in the absence of temperature difference), and the primary effect of the cowl may be estimated by the amount of energy which it takes from the wind and diverts to producing or maintaining a flow. We may call this the aëromotive force on the analogy of an electromotive force of a battery maintaining an electric flow in a circuit.

This conversion of the energy of wind into aëromotive force is in itself a very interesting subject. There is no doubt that by suitable mechanism of the windmill type (hinted at by the Archimedean screws of some revolving cowls) the wind could be made to lift through a chimney, not only air, but also, if desired, the cinders or the coals, and even the firegrate and the hearthstone itself; but the limits of effectiveness of purely pneumatic as distinguished from mechanical arrangements would be a very useful and productive subject for study. To take the matter a stage further in detail and ask whether it is possible by any combination of plane or curved surfaces to make the velocity of the air passing over the mouth of a tube greater than the original velocity of the wind, is to suggest an inquiry with important bearings upon many scientific subjects. For example, when wind blows through a truncated cone along the axis of the cone, is the velocity of emergence greater than the velocity of the unimpeded air? The cowl results do not answer this question, but indicate some suggestions. They show that a large cowl is more effective than a smaller one of similar pattern upon the same pipe; that the output of a pipe can be considerably increased by surmounting it with an extending cone-piece and adding at the widened end a "louvre" band attached by a regulated number of "feathers," and above that a cap at a certain distance. Whether this arrangement actually increases the velocity of the air passing over the mouth of a tube or merely prevents diminution only a master of theory can say. There is no experimental answer to this question.

Just as the current in a galvanometer gives no final indication of the electromotive force of a battery in its circuit, so the air current in the tube gives no final indication of the aëromotive force of the cowl. The resistances of all parts of the circuit and any accessory aëromotive forces must likewise be accounted for.

The resistances to be accounted for must refer to all parts of the complete circuit and are more complicated than electrical resistance, for they depend partly upon friction in which the loss of energy is proportional to the first power of the velocity and partly upon the turbulent motion in which the loss of energy is proportional to the square of the velocity. There are also in the circuit of flow arranged in the cowl experiments other aëromotive forces than that due to the cowl. In order to make this clear, it is sufficient to point out that the circuit consisted of the cowl, a length of three-inch pipe, an air meter, a short pipe opening into a box with a silk gauze base, and some opening, either door, or window, or chinks, between the interior of the hut where the observer was accommodated and the outside air. If the cowl had been removed the flow would not have ceased; even if the long tube were removed altogether there would be some flow through the opening, and if the opening were in the side of the hut instead of the top there would still be flow, thus indicating aëromotive forces quite apart from that due to air passing over the cowl or the top of the open tube.

The cowl committee made no inquiry into the different elements which go to make up the composite effect read on the air meter, and consequently made no attempt to analyse the effect of a cowl into the production of aëromotive force and resistance, just as the effect of a battery may be analysed into the production of electromotive force and electrical resistance. As downdraught is reversed flow, the same kind of uncertainty attaches to the results of the committee's experiments upon this branch of the subject.

The most confusing results are those for cowls used as injectors. In the case of exhaust cowls, comparison was made between the flow in three parallel pipes, the middle one carrying the cowl, the other two bare. The direction of the flow was the same in all three and all were fed from the interior of the same hut. When the effect of an injector was to be measured it was mounted upon the middle pipe, the outside pipes still remaining free. The aëromotive force in the injector pipe was, of course, reversed; one pipe supplied air to the hut and two extracted air from it. In that case flow could go on if the hut were otherwise hermetically sealed, and allowing for the hut being leaky, as it was, intentionally so, the network of currents is so complicated that it is difficult to attribute any precise meaning to the relation of the flow down the middle pipe and to that up the outside pipes, the relation selected by the committee to represent the effectiveness of the injector.

I have given some justification of the statement that the results obtained by the committee are no more indicative of the characteristic action of cowls than galvanometer readings are of the characteristics of batteries; I should like to add some words in explanation of the parallel statement that they are no less so.

If the resistances in an electric circuit are all maintained the same and the only changes introduced are successive slight modifications of the battery itself, it is quite possible to obtain from the corresponding galvanometer readings sufficiently definite information about the effect of the changes in the battery. Examples analogous to this are afforded in the report by numerous comparisons of

the effect of the different aspects of what may be called polarised cowls or terminals, *i.e.* cowls or terminals the action of which is different according to their position with regard to the direction of the wind. One of the most conspicuous is that of a cowl of the same shape as the torpedo air extractor now so much in use on railway carriages. From the numbers given, the apparatus is clearly much more effective when the wind crosses the opposed cones than when it passes along the cones and through the ring, and this difference of action is definitely characteristic of the two positions of the cowl.

Towards the end of the period of its labours the committee began to approach the question in more academic or philosophical fashion. Experiments with smoke were tried to see how cowls and terminals really acted. The committee was thus led to test the effect of successive variations of the number, size, position and arrangement of different modifying elements, such as a flange at the rim of the orifice or at a measured distance from it, a set of "feathers" arranged round the orifice and "louvre" bands or caps above it. A series of experiments to test the effect of the variation of a single element was carried out on single days and the results plotted in curves for the single varying elements. Here we have as results only galvanometer readings for different batteries, so to speak, but for batteries varying only in a single particular, and from such information effective inferences can be drawn about the action of the battery. These results afford the best material in the report for the scientific study of the action of cowls. It still remains only material, and requires working up with due regard to the theoretical considerations referred to. But some practical results follow directly. For example, a flange surrounding the orifice of the pipe diminishes the aëromotive force produced by wind passing over it, and if sufficiently extended practically annihilates the flow. It is not by any means impossible that an examination of these curves may lead to further investigation of the laws of flow through tubes under the action of passing wind. It is a subject which presents all the difficulties of the corresponding electrical problems, with some added in consequence of the inertia of the moving fluid, but it is of great practical as well as theoretical importance, and the report will have done good service if it attracts attention to the further study of the subject from this aspect.

One of the most amazing facts about the history of science in the last century is the little progress made in our knowledge of pneumatics compared with the advances in our knowledge of the flow of electricity, which still borrows its language for practical purposes from the older and now almost neglected study of the flow of fluids. The theoretical development of electricity can be attributed to Faraday's experimental investigation of the laws of electromagnetic induction. The flow of air along pipes in consequence of wind passing over the top may fairly be regarded as a case of pneumatic induction. The experiments of the cowl committee, if they have not succeeded in classifying these inductive effects into laws, have reopened the study of the subject, and at least give evidence that it is not the fulness of experimental knowledge that has dissuaded the intellects of the students of our laboratories from its investigation.

W. N. SHAW.

GOLD IN INDIA.

INDIAN gold is attracting the attention of the Geological Survey of India. In NATURE for May 9, 1901, we directed attention to Dr. F. H. Hatch's report on the Kolar gold-field in Mysore. We have now received reports on the gold-fields of Wainád, by Mr. H. H. Hayden and Dr. Hatch, and on some auriferous localities in north Coimbatore, by Mr. Hayden (*Mem.* Geol. Survey, India, vol. xxxiii. part ii, 1901.) These districts lie to the south of Mysore. The extraordinary discrepancy between reports made on various properties of Wainád by mining experts and the actual results subsequently obtained have justified independent investigations on the part of the Indian Government. It is recorded that in 1880 numerous companies, having an aggregate capital of more than four million pounds, were floated on the London market; of these only three companies retain their properties, and no work has been done for a number of years. The question to be solved was whether improved modern methods might render it possible to revive the gold-mining industry in the area. Dr. Hatch's report is, however, unfavourable. Dealing specially with two mines, he finds that ore does not occur in payable quantity, and he is unable to recommend further prospecting. Mr. Hayden gives an interesting historical sketch of the gold-mines, and describes in some detail the geological features of the district. The country-rock is in most cases biotite gneiss; this has been affected by a series of parallel fissures which run obliquely to the direction of the foliation, and in these fissures the vein-material was deposited. Pyrites proved to be the chief source of the gold, but the richer ore-bodies are small irregular patches, not of sufficient extent to be of material value.

Mr. Hayden remarks that there are few auriferous areas in India, poor as well as rich, that have not at some period or other been exploited by the natives; but the fact that gold was obtained in sufficient quantity to cover the expenses and leave a margin of profit, does not in itself justify the belief that a good margin of profit would be obtained if modern methods of working were adopted. Many of the reefs were probably mined by forced labour or by slaves. Thus one of the Wainád reefs, which was, perhaps, worked more extensively than any other, has given, from nearly 200 samples, an average yield of about two pennyweights of gold to the ton of ore. In Coimbatore there are numerous old native workings for gold, but they are, as a rule, small and unimportant, and the ore-bodies are either very thin or barren. Further prospecting, however, appears to be advisable in this district.

NOTES.

THE attendance of the Prince of Wales at the meeting of the Royal Society on Thursday last is an event which we have pleasure in recording. His Royal Highness was formally admitted as a Fellow of the Society, and remained throughout the meeting. At the close of the proceedings he was invited by the president to address the meeting, and in response he said:—"Mr. President, my lords and gentlemen,—It gives me very great pleasure to have been able to come here to-day and to be formally admitted as a Fellow of this ancient and distinguished society. But, as you conferred the honour of Fellowship upon me some eight years ago, I really ought to apologise for not having presented myself before. I can only say I am indeed proud that my name should be added to those on your illustrious roll, which has been inscribed by nearly every Sovereign since the reign of Charles II., and by all the most distinguished men of science since those days, such as Wren, Newton, Davy, Faraday, Darwin, and many others. I would wish to offer my sincere thanks to Sir William Crookes for his most interesting lecture, which I am sure we have all listened to with great pleasure. If I may be allowed to do so, I should like to congratulate him on his power of treating such an abstruse question (for I must confess that the title rather alarmed me) so as to make it intelligible and attractive to those who, like myself, unfortunately cannot lay claim to much scientific knowledge. But, while fully realising how far beyond my reach this

knowledge lies, I can assure you of my hearty sympathy with that scientific study and research, which now, more than ever, has become so important an essential in our national life."

AT the annual general meeting of the Royal Astronomical Society, to be held to-morrow, February 14, the Society's gold medal will be presented to Prof. J. C. Kapteyn, of Groningen, Holland, for his work in connection with the Cape Photographic Durchmusterung and his researches on stellar distribution and parallax. The Jackson-Gwilt (bronze) medal and gift will be presented to the Rev. Thos. D. Anderson, of Edinburgh, for his discovery of Nova Aurigæ and Nova Persei.

THE first afternoon meeting of the Chemical Society will be held on Wednesday next (February 19) at 5.30 p.m. Among the papers to be read are two on "Enzyme Action," by Prof. Adrian Brown, of Birmingham, and by Dr. Horace Brown, F.R.S., and Mr. Glendinning, and one entitled "The Union of Hydrogen and Oxygen," by Mr. H. Brereton Baker.

WE learn from *Science* that the Johns Hopkins University will celebrate its twenty-fifth anniversary on February 21 and 22, when President Remsen will be formally inaugurated. Dr. D. C. Gilman, president emeritus, will deliver a commemorative address on February 21, and President Remsen will give his inaugural address on the following day.

THE fall of red dust described by Sir Edw. Fry in last week's NATURE (p. 317) appears to have been observed over a wide area. Mr. F. H. Perry Coste sends us a cutting from the *Cornish Times* of February 8, in which it is stated that remarkable showers occurred over a large part of Cornwall during the latter part of January, the rain holding in suspension a fine dust, variously described as ranging from yellow or sandy-colour to whitish or brick-red. At Liskeard the deposit is spoken of as yellowy-red in colour; at Menheniot it had the appearance of brick-dust; at Calstock the deposit left by the rain was like fine yellow mud or sand; while, among other places in this neighbourhood, the dust attracted attention at Callington, Gunnislake and Altarnun.

THE Toronto correspondent of the *Times* writes that the Canadian Government regard with much satisfaction Mr. Marconi's recent success in signalling across the Atlantic. We rather question whether the results as yet obtained justify the hopes which seem to have been raised for a speedy establishment of cheap telegraphic communication between Canada and the mother country. More reasonable is the idea of utilising the system to its full in order to assist navigation at the mouth of the St. Lawrence. Canadian commerce, it is pointed out, will greatly depend in the future on the development of the St. Lawrence route, and there can be no question that navigation of the Gulf of St. Lawrence and the coast of Newfoundand would be much aided by a system allowing for communication between ship and ship and ship and shore.

THE Paris correspondent of the *Times* announces the death, at the age of seventy-two, of Mme. Clémence Royer, who first became known to the French reading public by her translation, in 1862, of Darwin's "Origin of Species." To this translation she prefixed what is regarded as one of the most famous essays in contemporary French thought. She was the author of "Le Bien et la Loi Morale" (1881) and of "La Constitution du Monde" (1900), and numerous original memoirs on archæology and anthropology. In 1895, MM. Berthelot, Aulard, Th. Ribot, Ch. Richet, Letourneau and Levasseur solicited for her the Cross of the Legion of Honour, alluding to her thus:—"Savante et philosophe d'une valeur rare c'est une des illustrations féminines de ce siécle." This decoration was not given her, however, until 1900, when the Minister of Education, M. Leygues, officially bestowed it at a banquet organised by Mme. Clémence Royer's Breton compatriots.

THE death is announced of Mr. William Martindale, the well-known pharmacist. From an account of his career in the *Pharmaceutical Journal* we learn that Mr. Martindale was born near Carlisle in 1840. In conjunction with Dr. W. Westcott he produced the very successful work entitled "Extra Pharmacopœia," which is highly appreciated by both physicians and pharmacists. For ten years (1873–1882) he was a member of the Pharmaceutical Society's board of examiners for England and Wales. In 1889 he became a member of the Society's council, in 1898 he was elected treasurer of the Society, and the following year he became president. He was president of the British Pharmaceutical Conference on two separate occasions; he was also a member of the council of the Royal Botanic Society, and interested himself in a scheme for the improvement of botanical teaching in London. In addition, Mr. Martindale was a Fellow of the Chemical Society, the Linnean Society, and a member of the Sanitary Institute and the Society of Arts. His position as a prominent pharmacist was recently indicated by his appointment as a member of the Privy Council's poisons committee.

A SHORT account of the results of the census of 1901 in France is given in *La Geographie* by V. Turquan. The population in each department is compared with the returns of 1801 and 1896, and the changes clearly shown by means of charts. It appears that between 1896 and 1901 twenty-eight departments show an increase averaging 25,200 each, if that of the Seine be included, or 16,000 if it be omitted, while fifty-nine departments show a decrease averaging 6000 each, a result indicating the movement of the rural population to the towns. The greatest per cent. increase is around Paris, in the departments of Nord and Pas de Calais, and along the shores of the Mediterranean; and the greatest decrease is in the basin of the Garonne, the department of Lot heading the list with a decrease of 6·1 per cent.

DR. H. FRITSCHE, director of the Pekin Observatory, has published the results of his investigation of the daily period of the elements of terrestrial magnetism, for the winter and summer seasons, based upon Gauss's general theory, and the hourly observations of twenty-seven places comprised between latitudes 80° N. and 56° S. This is the fourth work by the same author on the determination of the magnetic elements. The observations used have been collected partly from original publications and partly from those contained in the German *Meteorologische Zeitschrift*. The means are calculated from *all* the observations, including days of magnetic disturbance. Dr. Fritsche gives a detailed explanation of the formulæ employed.

THE current number of *Knowledge* contains an interesting note by Sir Samuel Wilks, F.R.S., on the history of Fahrenheit's thermometer, which, he states, owes its origin to the invention of a thermometer by Newton, described in the *Philosophical Transactions* for 1701. Newton's instrument was a tube filled with linseed oil, the starting-point being the temperature of the human body, which he called 12 (the duodecimal system being then in use); he divided the space between this and the freezing point into twelve parts, and stated that the boiling point would be about 30°. Fahrenheit, not finding the scale minute enough for his work in using Newton's instrument, first divided each degree into two parts and made it measure 24 instead of 12. Finding he could obtain a lower temperature than freezing by mixing ice and salt, he took this for his starting point, and counted 24 degrees up to body heat, making 8 freezing point and calling boiling water 53. Later on he divided each degree into four parts; it will be seen that if the last-mentioned numbers are multiplied by four, we have the thermometer which is now in use.

A YEAR ago the Scientia Club of Paris gave a dinner in honour of Prof. E. J. Marey, the eminent French physiologist, whose work has disentangled the intricacies of many animal motions. At the close of the banquet, Prof. Marey's numerous colleagues, friends and pupils expressed the desire to give tangible testimony of their admiration of his scientific achievements,

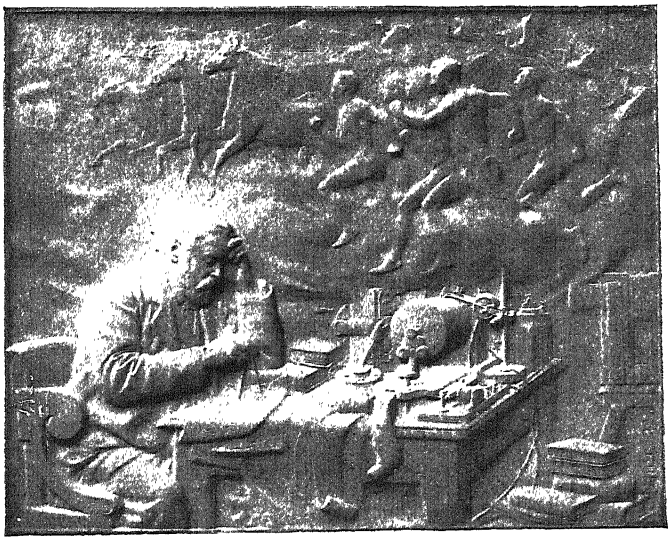


FIG. 1.—M. Marey in his laboratory. Reverse of medal.

and eventually it was decided to present him with a commemorative medal. This souvenir was engraved by Dr. Paul Richer, and the accompanying illustrations from *La Nature* show its remarkably fine character. The presentation was made to Prof. Marey at a meeting held at the Collège de France on January 19. M. Leygues, Minister of Public Instruction and Fine Arts, occupied the chair, and a large number of eminent men of science and other representatives of learning were present. M. Gaston Paris, administrator of the College, gave expression to the feelings of those who had combined to show their admiration of Prof. Marey's contributions to the study of physiological actions; and he was followed by M. Franck, one of Prof. Marey's old pupils, who described the work of his master. M. Chaveau spoke as an old and close friend, and M. Leygues, after referring to the chief characteristics of Prof. Marey's researches, remarked in conclusion:—"Je prie Monsieur Marey, au nom du gouvernement de la République, dont je suis ici le représentant, d'agréer l'hommage de sa reconnaissance et de sa respectueuse admiration." Letters and telegrams of congratulation were received from many physiologists unable to be present at the meeting; and Prof. Marey replied in appropriate terms of thanks to the numerous expressions of regard of which the medal which has been presented to him is a token.

REFERRING to the experiment described by Mr. F. Hodson in last week's NATURE (p. 319), Mr. J. D. T. Morris writes from the East London Technical College to say that it is possible to produce both kinds of electrification in sealing-wax by rubbing it with silk. As with the glass rubbed with fur, gentle rubbing produces positive electrification and more vigorous rubbing produces negative electrification. The change is probably due to difference of temperature of the surface of the material used, caused by the varying amount of energy used in the friction.

A NEW monthly journal has just been started at Florence, bearing the title *La nuova Rassegna tecnica internazionale*. It contains abstracts of important papers on engineering and applied science, a summary of current literature in this region, both Italian and foreign, notices of books, of exhibitions, prizes, vacant appointments and congresses. In the present number, projected railways and automobiles receive a fair share of attention. The *Rassegna* should be useful in giving a synopsis of the most important topics of the day in connection with practical engineering.

SOME interesting details relative to trials with secondary batteries for electric traction on branch lines of railway in Germany are given in the issue of the *Centralblatt für Accumulatoren- und Elementenkunde* for December 15, 1901. These trials were instituted in 1898, after a special form of Planté cell had been devised for the particular work. The negative plates of the cells were found in actual use to have a shorter life than the positive plates, and it was necessary to take these out and to repaste them after they had done duty for 30,000–40,000 km. The batteries were carried under the seats of the carriages, and weighed fifteen tons; while the complete weight of a carriage, with its motor equipment and complement of 112 passengers, was fifty-three tons. Two of these larger carriages and two smaller ones, with accommodation for sixty-eight passengers, were built, and were regularly run on branch lines connecting the following towns in the Palatinate:—Ludwigshafen Neustadt, Worms, Schifferstadt, Landau and Amweiler. The normal speed at which these carriages were run was one of 45 km. per hour. The total cost of the larger carriages was 2750*l*., the electrical equipment representing 1625*l*. of this total. The running costs are stated to have been 27·5 pfg. per car kilo-

FIG. 2.—M. Marey, Member of the Institute of France. Face of medal.

metre when generating charges were included, and only 21 pfg. when the batteries were charged at the central lighting station—presumably in Ludwigshafen. The corresponding charge for

steam traction is stated to be 28 pfg. In the light of these trials the use of accumulator traction on short branch lines of railway, is considered to be practicable and economical.

Prof. Holborn, of the Reichsanstalt, Berlin, has designed a new form of electric resistance laboratory furnace, which permits temperatures up to 1500° C. to be attained with ease by use of the ordinary 110-volt electric supply. These furnaces are made in two forms, the first being adapted for heating crucibles and the second for heating tubes 44 cm. in length. Both forms of furnace are alike in principle, the electric current being conducted through a resistance coil of platinum or nickel wire, wound round a thin porcelain tube or cylinder. The crucible or substance to be heated is placed within this latter, and the space between the outer side of the coil and the containing vessel is packed with asbestos or powdered quartz. Using nickel, the temperature of the furnace cannot be raised above 1000° C. without damage to the coil, but with platinum it is possible to attain a temperature of 1500° C. with a current of 14 amperes and 110 volts. It is necessary in the use of these furnaces to include a resistance in the circuit and to use only one-half of the maximum current when the heating is first commenced. The use of exterior resistance enables the temperature of the furnace to be regulated with ease, within somewhat narrow limits. Further advantages claimed for these furnaces are—that the separate portions are replaceable when worn out, that the heating spirals can be easily removed and changed to suit the special temperatures required, and that with the tube form of furnace, the heating of the substance can be carried on in the absence of air and in the presence of any desired gas or gaseous mixture. It would be interesting to know whether any attempts have been made to apply electrical resistance heating, to organic combustion work. The usual type of gas-heated combustion furnace is capable of improvement, and the substitution of electricity for gas would bring with it some notable advantages. In localities where the day supply of electricity is at reduced rates, this application is worthy of attention.

The climate and artesian waters of Australia form the subject of an essay by Mr. J. P. Thomson (Queensland *Geographical Journal*, vol. xvii. No. 2, 1902). The author maintains that the great central basin of Australia, as well as certain valleys within the area, are hemmed in by ancient crystalline, Palæozoic and Mesozoic rocks of an impervious character; and that during the Cretaceous period the valleys were filled up and the level of the central basin raised by detritus from the adjacent mountain ranges. Thus extensive beds of sand and gravel were spread out, and these were followed by a deposition over the central area of fine clays and shales. The clays to a certain extent seal up the water which is held in the Cretaceous sands and gravels, and thereby a good source of artesian water is provided. Since his paper was printed, Mr. Thomson announces (*Brisbane Telegraph*, December 28, 1901) that the existence of an abundant supply of good drinking water has been proved at a depth of 30 feet in the Eucla district north of the Great Australian Bight. This discovery indicates that inland settlements may be feasible in tracts which furnish good indigenous bush feed for cattle, but have hitherto been regarded as drought-stricken.

We have received a copy of a paper by Mr. P. Frandsen, published in the *Proceedings* of the American Academy (vol. xxxvii. No. 8), on the effects of directive stimuli on slugs. It appears that, as the result of previous experiments, it has been stated that when slugs are placed on an inclined plane of glass, some move in an upward and others in a downward direction. One of the objects of the author's investigations was to test the truth of this statement, and, if true, to find a reason for the diversity of habit.

In his presidential address to the Edinburgh Field Naturalists' and Microscopical Society, which appears in the *Transactions* for 1901, Mr. W. C. Crawford gives an interesting account of the ant-colonies shown in the Paris Exhibition, and suggests that similar exhibits might with advantage be introduced into this country. In the same volume, Mr. T. Speedy gives some interesting notes on the life-history of the badger, while Mr. A. A. Pinkerton discourses on the habits of the mole. In the course of his paper the former gentleman states that it is a common belief that young badgers do not suckle till a considerable time after birth.

Special interest is attached to Mr. R. Quick's paper on "Human Bone Instruments" in *The Reliquary and Illustrated Archaeologist* (vol. viii. January, 1902, p. 28), as the figures which illustrate it are from specimens in the Horniman Museum. It will be in the memory of our readers that this really remarkable museum was given last year by Mr. Frederick John Horniman, M.P., to the London County Council to be freely open to the public. In Mr. Quick's somewhat discursive paper an interesting series of three Tibetan drums is figured; the first is made of two human calvaria fastened back to back so as to form a sort of hourglass-shaped instrument, two knotted strings constituting the clappers. Another specimen is a brass model of two calvaria, and the third is a wooden one yet more conventionalised. Trumpets made from the thighbones of lamas and a lama's skull cap used as a drinking vessel are also illustrated.

A good deal of untrustworthy theorising has been applied to textile markings found on the pottery of primitive peoples; Mr. W. H. Holmes has a careful, discriminating paper on this subject in the *American Anthropologist* (iii. 1901, p. 397). He finds pottery so marked can be divided into five classes: (1) Impressions from the surface of rigid forms, such as baskets; (2) Impressions of fabrics of a pliable nature, such as cloths and nets; (3) Impressions from woven textures used over the hand or over some suitable modelling implement; (4) Impressions of cords wrapped about modelling paddles or rocking tools; (5) Impressions of bits of cords or other textile units, singly or in groups, applied for ornament only and so arranged as to give textile ike patterns. In addition we have a large class of impressions and markings in which textile effects are mechanically imitated. Those who are interested in our own prehistoric pottery should study Mr. Holmes' paper.

A new volume of *The Geographical Journal*, containing the numbers published in the latter half of last year, has been received. Among the papers in the volume we notice the following as of wide interest:—Sand-waves in tidal currents, by Dr. Vaughan Cornish; the Antarctic voyage of the *Belgica* during the years 1897, 1898 and 1899, by Mr. H. Arçtowski; the anthropogeography of Argentina, by Dr. F. P. Moreno; the National Antarctic Expedition; and the lake-level of the Victoria Nyanza, by Mr. E. G. Ravenstein. There are in addition a number of papers on explorations, accompanied by maps, and the usual monthly record of progress in the knowledge of geography.

Messrs. Sanders and Crowhurst have sent us for examination a number of brilliant lantern slides of birds and other zoological subjects. Photography has been a helpful handmaid to many branches of science, but none of its performances are more widely appreciated than those in the field of natural history. Drawings of animals may have artistic merit, but they do not inspire the feeling of life which is conveyed by good

photographs of objects in their natural surroundings. The lantern slides sent by Messrs. Sanders and Crowhurst are from photographs of birds, nests, eggs and young and other living animals taken by Mr. Oliver G. Pike. To lecturers on natural history such true pictures of living creatures must be invaluable, and no better source of encouragement to study nature could be desired. By the side of such beautiful photographic pictures as are now available for projection upon a screen or for the illustration of books, the drawings which did duty in natural history instruction seem but a vain show. Messrs. Sanders and Crowhurst send us with their slides an ingenious arrangement for viewing lantern slides under a low magnifying power. The arrangement, though simple, is very effective, and a pleasant half hour can be passed by using it to look at lantern slides.

THE additions to the Zoological Society's Gardens during the past week include a Greater Vasa Parrot (*Coracopsis vasa*) from Madagascar, presented by Lady Amherst of Hackney; a Black-footed Penguin (*Spheniscus demersus*) from South Africa, presented by Lieut. F. J. Mosely; a Black-headed Gull (*Larus ridibundus*), European, presented by Miss M. Hall; a Bataleur Eagle (*Helotarsus ecaudatus*) from Lagos, presented by Mr. J. Peacock; two Yellow-cheeked Amazons (*Chrysotis autumnalis*) from Honduras, two Wall Creepers (*Tichodromus muraria*), European, deposited.

OUR ASTRONOMICAL COLUMN.

DISTURBANCE OF CORONA IN NEIGHBOURHOOD of PROMINENCES.—Prof. C. D. Perrine, who had charge of the expedition to Sumatra organised by the staff of the Lick Observatory to observe the total eclipse of the sun on May 18, 1901, gives in his report a preliminary description of the results obtained in the *Astrophysical Journal*, vol. xiv. pp. 349-359. From a short examination of the photographs of the corona obtained with the forty-foot and Floyd telescopes (which are stated to show the details of the inner corona very perfectly in spite of the presence of clouds during the exposure), there is distinct evidence of disturbances in certain areas of the coronal structure. Especially noticeable is a conspicuous series of coronal hoods surrounding a prominence in position angle 115°, and also an unusual appearance in the north-east quadrant of the corona. This latter is near position angle 65°. Close to this point on the limb there is a small compact prominence, surrounding which the disturbed area has a form roughly resembling an inverted cone of large angle. The apex of this area is not visible, appearing to lie below the chromospheric layer showing at the limb. From the apparent position of the apex, a number of irregular streamers and masses of matter radiate as if propelled by some explosive force. A long thread-like prominence to the south of this point appears to originate from the same source. Above and around this region the corona is composed of broken irregular masses, very similar to those depicted on the photographs of the Orion and other nebulæ.

A NEW SOLAR THEORY.[1]

IT is a remarkable fact that in the numerous theories which have been propounded in explanation of the periodic changes of the solar phenomena no account has yet been taken of so important an element as the light- and heat-absorbing envelope surrounding the photosphere. The attention which this so-called solar atmosphere has hitherto received, on the part even of our most eminent investigators, in connection with the economy of radiant energy on our luminary, is utterly disproportionate to the importance of the subject. In spite of the fact, which was first accurately established by Langley's observations and was afterwards confirmed by others, that the sun, if deprived suddenly of this protecting screen, would radiate into space as much as double its present amount of energy, solar physicists failed to perceive that changes in the absorptive power of this envelope must entail consequences of the most far-reaching character with respect to the thermal conditions on and in the sun. That such changes—and these, too, of no inconsiderable magnitude—must inevitably occur is a conclusion which it is hardly possible to evade when it is remembered that the supreme control over the dispensation of solar energy depends entirely on a thin, shallow surface-layer, the matter of which is constantly tossed about by vehement eruptions and acted upon by a most complicated and powerful system of convection currents to and from the sun's centre.

The possibility of variations of the opacity of the solar atmosphere was, it is true, strongly urged, more than twenty years ago, by one of the greatest authorities on this question. Shortly after his well-known researches into the absorbing faculty of the solar envelope, Langley pointed out the decisive influence on the sun's radiation into space caused by changes in the transmissive power of its atmosphere. But his attention was at the time solely directed towards their probable effects on the temperature of our own planet. He found that an increase of absorption by as much as 25 per cent. would diminish the mean surface temperature of our globe by 100° F., whilst a like diminution in the solar envelope would produce a corresponding change in the opposite direction.

Now if the influence of a change in the absorptive power of the solar atmosphere is so enormous on a planet at a distance of almost a hundred millions of miles, of what inconceivable importance must it not be for the sun itself? Drawing the very natural inference that a *deficit* of outside radiation means a *surplus* of energies working upon the solar matter, and *vice versâ*, we are forcibly led to conclude that even slight changes of opacity, such as would elude our most refined observations, are bound to greatly influence the state of thermal equilibrium on our luminary.

Hence, if changes in the absorptive power of the sun's atmosphere exist, as cannot but be the case, the question presents itself: What happens with those energies which, by a condensation of the solar envelope, are prevented from escaping into space? No doubt they are preserved to the sun, but in what form? Do they raise the temperature of the solar mass, or augment its store of potential energy, or have they a share in the generation of those marvellous dynamical displays which we perceive in periodic succession on the solar surface? Questions such as these must tend to convince the investigator that a research into the causes of the variability of the forces which we see acting on the sun, if not identical with, is at least closely akin to, the investigation of the origin and the physical properties of the sun's atmosphere. I shall endeavour, in these columns, to demonstrate the possibility of such changes in the density of the solar envelope as would lead to alterations of the thermal conditions of the sun's mass, and shall make an attempt to answer the question as to how far these changes must be conducive to variations in the dynamical phenomena at the sun's surface.

There is perfect unanimity amongst astronomers as regards the nature of the force which by a continuous generation of heat compensates for the loss of energy into space. Helmholtz's theory, which attributes this heat-generation to the progressive contraction of the solar mass as a consequence of gravitation, may be regarded as one of the most probable hypotheses ever propounded in the history of physical science. But this theory does not yet enable us to form an idea of the evolution of a celestial body. It explains the existence of a heat-generating force within the star's bulk, but it gives no answer to the question as to whether the loss of energy by radiation is exactly compensated for by the generation of energy through contraction, or whether the conditions of contraction peculiar to the sun may not perhaps produce *more* or *less* heat than is required for compensation. It is, indeed, inconceivable that the conditions of contraction can remain the same throughout the lifetime of a star. The spectroscope has revealed the fact that the photospheres of different stars exhibit widely different stages as regards temperature. There are doubtless suns hotter than ours, and others considerably cooler. And we may confidently assume that the various conditions of temperature now recognised in the different types of star-spectra represent the phases which successively appear in the evolution of each of these bodies from its origin as a far-extended nebula down to its complete obscuration. In the life of each of these stars there will be a period when its temperature is on the ascent, and when, consequently,

[1] Abstract of a paper in *Astr. Nachr.* (No. 3723-24): "Ueber eine neue Theorie zur Erklärung der Periodicität der solaren Erscheinungen."

the heat-generating effect of the contractile force exceeds the loss by outward radiation, as well as another period when the declining temperature of the star indicates an excess of the heat-dissipating over the heat-producing forces. Which of these conditions, at the present moment, prevails on our sun can so far be only a matter of conjecture. In this respect, therefore, an assumption has to be made. The following inquiry applies to the case of a star on which the generation of energy by contraction falls short of the loss of energy by radiation. Whether the results of this investigation may be applied to the case of our sun must, then, depend on the further question whether the sun really belongs to those stars the temperature of which is declining. So far as I know, this latter opinion is at present held by the great majority of astrophysicists.

If on a star the loss of energy exceeds the production, the kinetic energy of its molecules, and consequently its absolute temperature, must decrease. Hence if the temperature of a layer, a_n, at a certain distance, ρ_n, from the centre was T_1 at the epoch t_1, it will be T_2 at a later epoch t_2, where $T_2 < T_1$. Now let a_1 be the level of the photosphere—or the level of maximum incandescence, and therefore also of maximum radiation—at the epoch t_1. In consequence of deficient contraction the temperature of this layer must decrease, and the materials composing it must cool down, so that, at the subsequent epoch t_2, the level of maximum incandescence will have shifted towards a layer, a_2, nearer to the star's centre, where the temperature is still sufficiently high to maintain the incandescent state of all the particles. The space between a_1 and a_2 will then be occupied by particles in a less luminous state which act as an absorbing screen on the radiation emanating from a_2. Whatever fraction of the total radiation which originally left the photosphere at a_2 is thus stopped in its outward progress will be in part absorbed by, and in part reflected from, the intervening particles of the layer a_1a_2, and there can be no doubt that some at least of this arrested energy will ultimately be thrown back to a_2 from which it started. The layer a_1a_2 must therefore act on the photospheric radiation in the same way as do our atmosphere and its clouds on the radiation from the soil. We are quite familiar with the fact that clear nights are, as a rule, cooler than cloudy ones, and we explain this phenomenon by the assumption that on clear nights radiation from the soil into space goes on more freely than when clouds offer an effective impediment to the dissipation of radiant energy.

We conclude, then, that the progressive cooling of the star leads to the formation of an absorbing envelope above its photosphere, by which the disproportion between the generation and loss of energy is reduced. But if, under the conditions at the epoch t_2, the amount of energy actually radiated into space still exceeds what is produced by contraction, the photosphere will move to a_3, still nearer to the centre, and the quantity of absorbing matter in the layer a_1a_3 will be further increased. Now although a_3 emits the same quantity of energy as did a_2 and a_1 at the former epochs, the total amount of radiation emerging into space must, at the epoch t_3, be less than it was at t_2 and t_1. Thus the opacity of the cooled atmosphere gradually increases as time goes on, and the total radiation of the star becomes less and less. Since no force is present to interfere with the cooling of the layers $a_1, a_2 \ldots$, a moment t_n must eventually be reached at which the photosphere at a_n, through reflection from all the layers above it, receives back so much of its radiation that its total expenditure of energy is exactly counterbalanced by the energy contributed by the contractile forces.

This result appears to be of eminent importance. For it shows that even on a star with deficient contraction the *exact* compensation of the loss of energy may still be possible from a certain layer downwards. This state, so exceedingly important for the conservation of energy within the star, is brought about by the progressive cooling of its superficial layers, which thereby increase their power of absorption and thus offer a more and more effective check to the radiation from the incandescent layers below.

Here, now, we are confronted with a question which leads us at once to the principal object of this inquiry: Can the state of thermal equilibrium thus eventually attained by the layer a_n be permanent? The answer is clearly negative. For when a_n has arrived at this state, none of the layers $a_1, a_2 \ldots a_{n-1}$ outside a_n have reached the same condition. Their cooling is bound to go on, and consequently their ability to absorb and reflect the heat emanating from the layer a_n must still further increase even after the establishment of thermal equilibrium at a_n. But, owing to this increasing amount of reflection towards it, the layer a_n will now dissipate even *less* energy than is required for the maintenance of thermal equilibrium, and therefore must become *overheated*. It thus comes to pass that, while the function of the absorbing envelope is that of reducing as much as possible the waste of energy from the photospheric layers, it is, by the very nature of this process, compelled to *overdo* its work, and to preserve finally too much energy within the star.

Now by this gradual overheating of the inner layers the vertical temperature-gradient must increase more and more, until it reaches a degree of steepness at which the permanence of a mechanical equilibrium becomes impossible. In such a case the overheated gaseous matter will force its way outwards and will break through the "cloak" of absorbing elements above it. But the overheated matter will not at once obey its molecular impulse to escape into higher levels. We must remember that there exists a powerful system of convection currents between the interior and the surface of the sun, and that the overheated particles may for some time be swept along the paths of these currents and may thus be forcibly detained in levels inconsistent with their increased temperature, so that their state of equilibrium is rendered unstable. This will produce a tension which increases in course of time until the upward tendency of the overheated particles becomes strong enough to overcome the resistance of the currents. At such a critical moment even a slight disturbance will be sufficient to induce the upward motion so long restrained, thus giving rise to a solar eruption. The cause of a solar outburst is therefore to be found in the temporary existence of an excessively great vertical temperature-gradient caused by progressive cooling of the outer atmospheric layers and the ensuing overheating of the inner photospheric layers.

From this exceedingly simple principle we are able to deduce an analytical demonstration of the periodicity of solar phenomena which explains all the characteristics of the sunspot curve hitherto observed. Obviously, the problem consists in demonstrating the changes in the amount of outward radiation which are caused, on the one hand, by the increase of absorptive power of the atmosphere in consequence of its progressive cooling, and, on the other, by the reduction of absorptive power of this same atmosphere in consequence of the "clarifying" action of eruptions which, by breaking through the "veil," diminish the number of cooled absorbing elements at the localities of eruption. I shall not enter upon this part of my investigation in the present note beyond stating that it is a simple application of Bouguer-Lambert's formula for the extinction of light and heat in an absorbing medium. The energy ϑ of the radiation leaving the upper limit of the atmosphere is found by the differential equation

$$\frac{d^2\vartheta}{dt^2} + a\frac{d\vartheta}{dt} - a\beta\vartheta = o,$$

where t denotes the time reckoned from the moment when the photospheric layer a_n has attained its state of thermal equilibrium, and a and β represent constants, the former of which depends on the rate of cooling of the atmosphere, the latter on the action of the eruptions. The integral of this equation will thus give us the changes in the radiating power of the sun towards a point in the universe. Considering that the intensity of the dynamical phenomena at the solar surface must depend on the excess of energy preserved to the sun beyond what he requires for the maintenance of thermal equilibrium at a_n, we arrive at the following theoretical equation for the frequency of eruptions and spots:—

$$r = a\left[1 - e^{\lambda_1 t} + \frac{e^{\lambda_1 p} - 1}{1 - e^{\lambda_2 p}}\left(1 - e^{\lambda_2 t}\right)\right]$$

where p is the period and

$$\lambda_1 = -\tfrac{1}{2}a + \sqrt{\tfrac{1}{4}a^2 + a\beta}$$
$$\lambda_2 = -\tfrac{1}{2}a - \sqrt{\tfrac{1}{4}a^2 + a\beta}.$$

It is readily seen that r starts from zero at the moment $t = o$, and that it reverts to zero at the moment $t = p$. Between these two moments r attains a maximum, and we find the time when this occurs from the equation

$$e^{(\lambda_1 - \lambda_2)t_m} = \frac{\lambda_2}{\lambda_1}\frac{1 - e^{\lambda_1 p}}{1 - e^{\lambda_2 p}}.$$

Now it can be shown that the right-hand side of this equation is under all conditions $< e^{(\lambda_1-\lambda_2)\frac{p}{2}}$, and this the more so the greater the difference between λ_1^2 and λ_2^2. Hence we deduce $t_m < \frac{1}{2}p$; *i.e.* the ascent from zero to the maximum must take place in an interval of time shorter than half the period. This constitutes the first theoretical proof of the well-known property of the observed spot-curve that the ascent is steeper than the descent.

To give some idea of the accuracy with which the above theory can be made to represent the observed facts, I subjoin a plate (Fig. 1) in which the spot-curve, resulting from theoretical considerations, is compared with Spörer's curve derived from observation. A full description of the method by which the theoretical curve has been obtained will be given in a paper shortly to be published as part of the first volume of the *Annals* of the Royal Observatory, Edinburgh.

The theory also accounts satisfactorily for the existence of a "great" period of solar phenomena. This greater cycle is brought about by the influence of the surface fluctuations of temperature described above on the intensity of the convection currents which regulate the interchange of heat between the interior and the surface. It is inconceivable that in a gaseous body like the sun, governed by a gigantic convection, changes of temperature of parts of its mass can be confined merely to the surface. Hence we must conclude that the distribution of temperature throughout a considerable part of the sun's bulk will be more or less affected by the fluctuations of temperature at the surface, and that consequently the intensity of the system of convection-currents, which depend on this distribution of temperature, must undergo variations similar to those exhibited by the dynamical phenomena at the surface. Now these variations must react on the development of eruptions and spots. If the currents are weak—viz. if the transfer of heat from the interior to the surface is comparatively small—the cooling of the atmosphere must proceed rapidly, and hence the development of eruptions, which are a direct consequence of this process of cooling, must be energetic. At such times we have, therefore, to expect solar cycles with a powerful display of dynamical phenomena. If, on the other hand, the currents are intense—viz. if the heat-supply from the interior is vigorous—the rate of atmospheric cooling will be small, and we have then to expect cycles with only a weak development of surface phenomena.

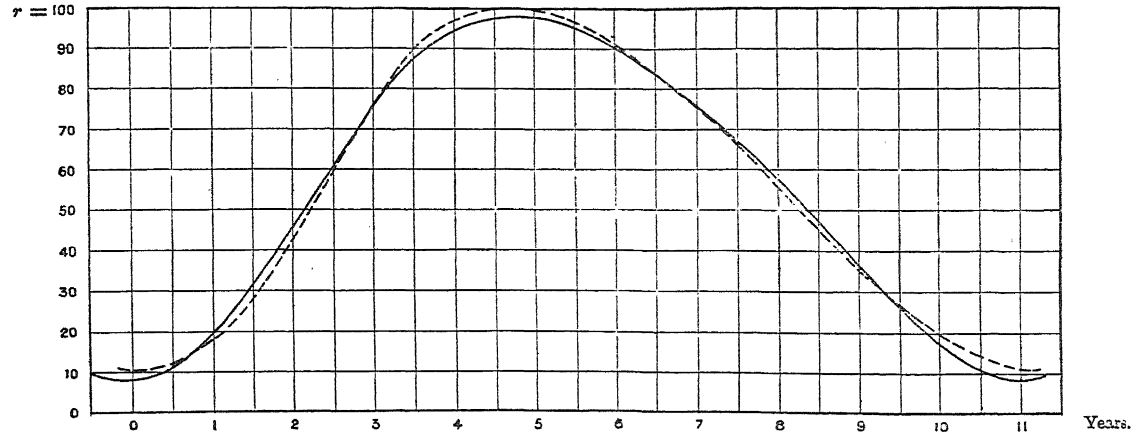
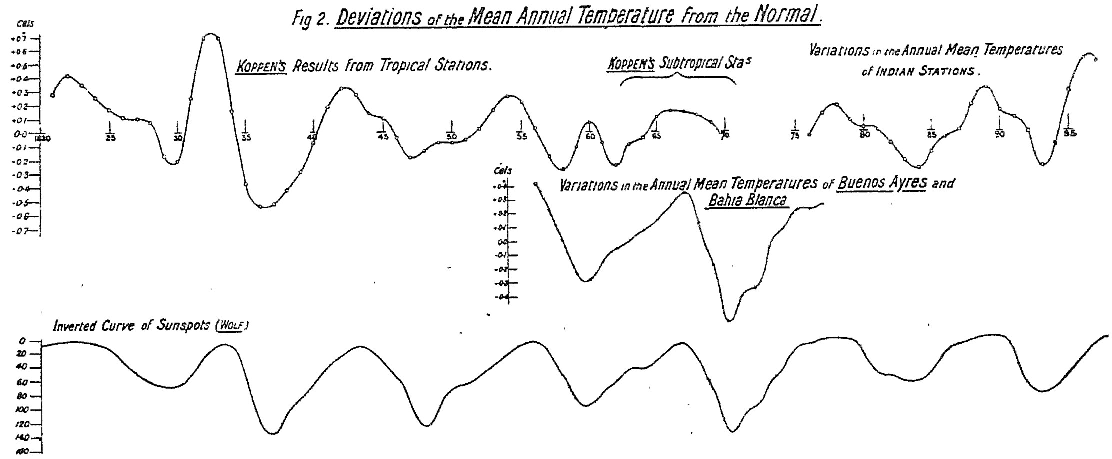


FIG. 1.——Theoretical curve of solar spots. . . . . . Observed curve of solar spots (Spörer).

Since the quantity α depends on the rate of cooling of the atmospheric layers, it will attain high values at times when the spot-development is powerful, and *vice versâ*. Now the greater α, the greater will be the difference between λ_1^2 and λ_2^2, and, consequently, the earlier must the time of maximum, t_m, occur. Hence the position of the maximum in the spot period relatively to the preceding minimum must depend on the greater or less vigour of spot-development during the cycle, inasmuch as the time of maximum must be the more in advance of the centre of the period the greater the display of the dynamical phenomena. This important conclusion, arrived at by purely theoretical considerations, is amply corroborated by the facts. I refer in this respect to a recent publication of Dr. W. Lockyer, in which this peculiar shift of the maximum is pointed out as a feature of the observed spot-curves.

Fig 2. Deviations of the Mean Annual Temperature from the Normal.



The object of this brief abstract being merely an exposition of the main principles upon which I have ventured to build a new solar theory, I shall not enter upon its various applications to the phenomena connected with the periodic changes in the

display of forces at the sun's surface. In this respect the theory will be submitted to an exhaustive test in my paper in the *Annals*. In one important point it involves a radical deviation from the views hitherto held. So far investigators have almost unanimously adhered to the traditional view that an increase in the dynamical forces at the sun's surface indicates at the same time an augmentation of his light- and heat-radiation into the universe. A theory founded on this assumption would have to account, not only for the extra expenditure of force into space, but also for the simultaneous increased development of force in the sun. But in the theory here proposed the exactly opposite conclusion is arrived at. Here the forces which we see acting on the sun are called into existence by the accumulation of such parts of his radiating energy as have been *prevented* from being thrown off into the universe. Thus a *surplus* of energy working on the sun means a *deficit* of energy communicated to space.

It will be important, then, to ascertain how far this conclusion can be verified by observed facts. Modern researches seem, indeed, to corroborate this theoretical result. If the theory be true, the temperature of the solar layers inside the absorbing atmosphere should be higher at the maxima than at the minima of solar activity, while the temperature of a body in space, which receives its heat from the sun, should vary inversely. In proof of the first conclusion I may refer to Sir Norman Lockyer's results with regard to the behaviour of the lines widened in the spectra of sunspots, from which he infers that the matter composing the spots must be of higher temperature at the times of maxima. The second conclusion, on the other hand, is corroborated by all the more important researches which have recently been made regarding a connection between the changes of terrestrial temperature and solar activity. Of some of these I subjoin the main results in Fig. 2, which exhibits the observed changes in the mean annual temperature at tropical and subtropical stations and the corresponding variations of solar activity. It will be seen that for the whole period from 1821 until 1898 the temperature-curve follows most accurately the fluctuations of the *inverted* spot-curve, thus so far proving the validity of the second conclusion, that space receives *less* heat at the maxima than at the minima of solar activity.

J. HALM.

MICROSCOPICAL EXAMINATION OF ALLOYS OF COPPER AND TIN.[1]

THE microstructure of the copper-tin alloys has been studied by Behrens, Charpy, Stead and others. Recently Messrs. Heycock and Neville (*Phil. Trans.* Royal Society, 1901; Glasgow meeting, British Association) have published several papers on the effect of quenching upon the microstructure. Behrens divides the bronzes into two principal groups—those rich in copper, containing from 1 to 25 per cent. of tin, and those rich in tin, containing more than 25 per cent. of tin. With the exception of the metals for mirrors (25 to 35 per cent. of tin), which appear homogeneous, Mr. Behrens says that in all bronzes a portion rich in copper or rich in tin may be detected, forming the fundamental mass, the former in alloys rich in copper, the latter in those rich in tin.

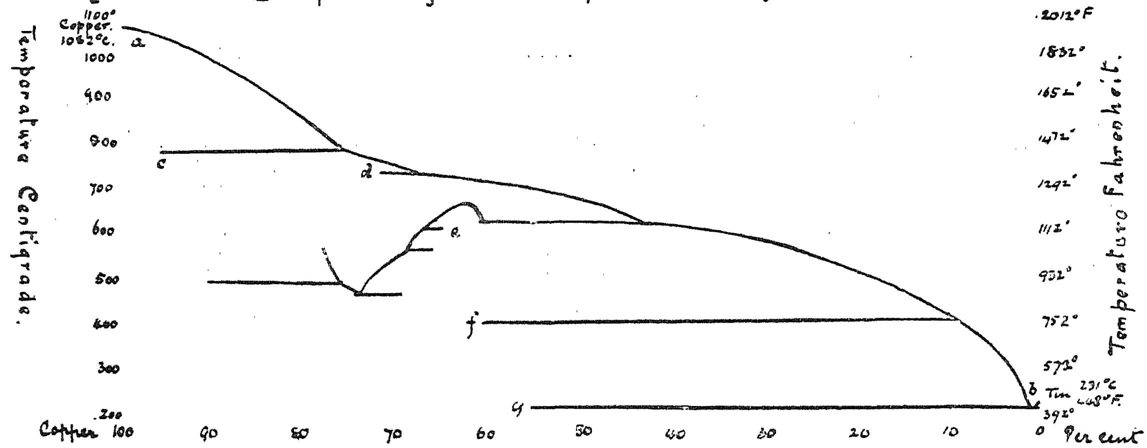
Charpy (*Metallographist*, vol. i. p. 193) divides them into those rich in copper, containing 100 to 73 per cent. of copper, and those rich in tin, which are again divided into four groups—0 to 3 per cent. of copper, in which tin crystallises in the matrix; 3 to 55 per cent. of copper, in which a compound of tin and copper crystallises out of the matrix; 55 to 65 per cent. of copper, which have a structure quite homogeneous and difficult to resolve; and 65 to 73 per cent. of copper, in which hard white grains crystallise in the higher eutectic.

The curve of fusibility, as determined by Le Chatelier, is composed of three branches, forming by their intersections two points corresponding to alloys with 3 and 72 per cent. of copper.

0 to 3 per cent. of copper:	straight:	fall.
3 to 72 ,, ,,	uniformly curved:	rise.
72 to 100 ,, ,,	almost straight:	rise.

This curve and the results of Charpy (*Bull.* Soc. d'Encouragement, March, 1897) from microscopic analysis closely agree.

Fig 1. Freezing-point Curve of Copper-Tin Alloys.
IV. Report Alloys Research Committee.



If, however, we study the complete cooling curve of th copper-tin alloys, by Sir William Roberts-Austen (Fig. 1), th meaning of only a part of the curve will be found to have been explained by previous workers. The branches *c*, *d*, *e* and *f* remain unaccounted for.

The result of the microscopical study of these alloys is shortly as follows:—

0 *to* 1 *per cent. Copper.*—On the addition of even 0·1 per cent. of copper to tin, a new constituent surrounding the grains of tin can be seen. As the percentage of copper increases, the amount of enveloping material increases also, and the tin grains decrease in size and number until about 1 per cent. copper; they entirely disappear when the whole mass is composed of the first eutectic alloy. When these alloys are cast, the grains of tin are greatly reduced in size.

1 *to* 8 *per cent. Copper.*—When the copper is increased above 1 per cent., thin bright needles are seen, which increase in size and number and vary in their method of grouping until 8 per cent. of copper is reached. Their composition varies also, increasing from 33·5 per cent. Cu to 44 per cent. Cu, as was pointed out by Stead (*Journal* of the Society of Chemical Industry, June, 1897). Casting produces a network of fine crystallites, which tend to set along definite directions forming skeleton crystals. Cooling in the furnace greatly increases the size of the bright crystals and diminishes their number proportionately.

9 to 40 *per cent. Copper.*—With 9 per cent. Cu a new constituent crystallises out in forms similar in section to the crystals

[1] Abstract of a paper by Mr. William Campbell, Columbia University, New York, late of the Royal School of Mines, London. Read before the Institution of Mechanical Engineers on December 20, 1901.

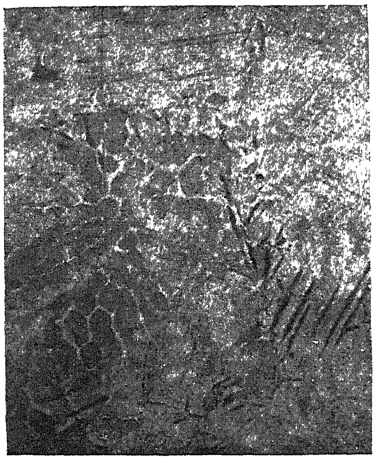


FIG. 2.—Cu 66 per cent. × 33. V.

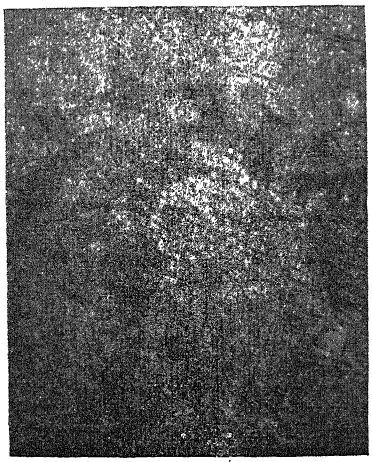


FIG. 3.—Cu 66 per cent. × 33. V.

FIG. 4.—Cu 66 per cent. × 33

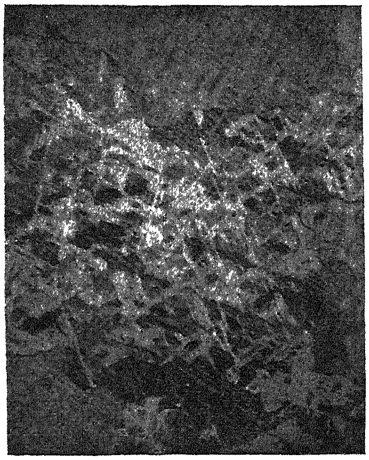


FIG. 5.—Cu 66 per cent. × 33. V.

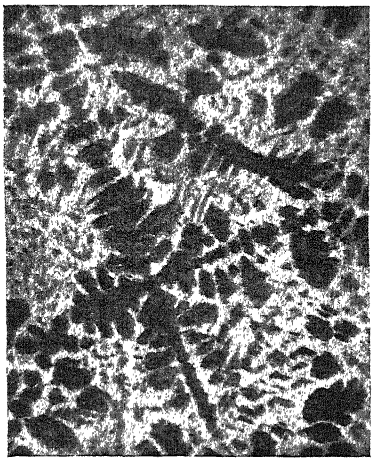


FIG. 6.—Cu 80 per cent., furnace-cooled, × 33. V.

FIG. 7.—Surface of Fig. 6.

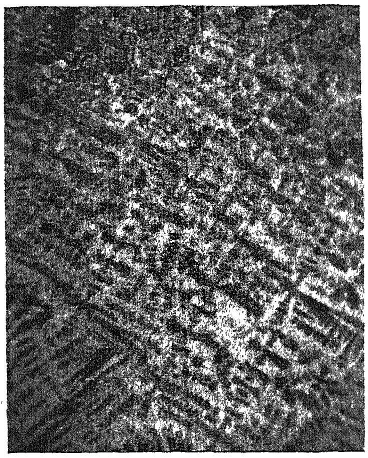


FIG. 8.—Cu 80 per cent. × 33. V.

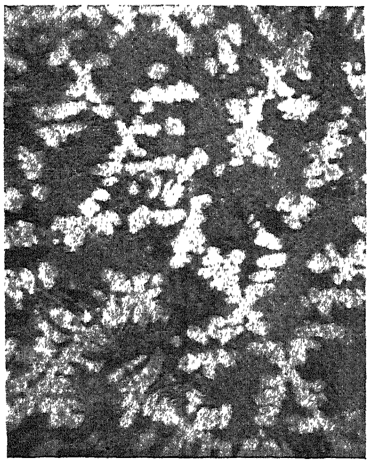


FIG. 9.—Cu 80 per cent. × 33. V.

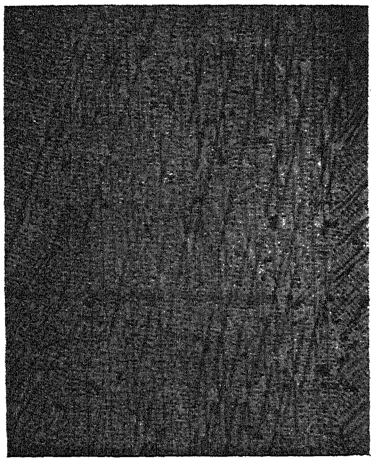


FIG. 10.—Cu 80 per cent., cast, × 33. V.

V, vertical illumination.

in the 1 to 8 per cent. alloys, but differing from them in never occurring hollow. On oxidation it becomes very dark and is easily distinguished from the other two constituents of the alloy. In form it is plate-like, and around it crystallises out the bright constituent characteristic of the 1 to 8 per cent. alloys, either as a rough envelope of fairly uniform thickness or as projecting crystals. Stead was the first to draw attention to the fact that the crystals of this division of the series were composite. As the copper approaches 40 per cent., the plate-like crystals are grouped together in parallel bunches. Casting masks the composite character of the crystals, if, in the lower percentages, it does not destroy it; for under 20 per cent. Cu, the crystals cannot be resolved into two components under high powers.

41 *to* 61·7 *per cent. Copper.*—At 41 per cent. Cu the crystals are small, lath-shaped, and arranged more or less in groups. The alloy is brittle, and this brittleness increases with the percentage of copper. With each addition of copper, the groups of composite crystals become more and more compact and the amount of eutectic diminishes until at 56 per cent. Cu it disappears (Stead, *Journal* of the Society of Chemical Industry, June, 1897), and the bright constituent of the crystals forms the groundmass. When 61·7 per cent. Cu is reached, the bright constituent disappears and we have a homogeneous mass of $SnCu_3$, probably a definite compound. Casting tends to harden and toughen these alloys. Seeing that these alloys up to about 56 per cent. Cu show four breaks in their cooling curves, one would naturally expect to find four different constituents in each. Only three, however, can be distinguished. Quenching below the first and second breaks gives a difference in structure only. As in the alloys containing 61·7 per cent. Cu and onwards, branch *e* of the curve (Fig. 1) corresponds to a rearrangement in the solid, and as the difference between the 40 and 41 per cent. Cu alloys is one of structure only, we may assume that the second retardation in the cooling curve (*e*) is one of rearrangement also.

61·7 *to* 68·28 *per cent. Copper,* $SnCu_3$ *to* $SnCu_4$.—The changes which take place between these two points can only be observed when the alloys are very slowly cooled. The alloys set as a whole at the first break and tend to rearrange themselves subsequently in the solid, on branch *e* (Fig. 1). Each addition of copper to $SnCu_3$ brings in more and more of a bright constituent, probably $SnCu_4$. Quenching and casting produces structures entirely new. Figs. 2–5 show the 66 per cent. Cu alloy differently cooled. Fig. 2 was quenched on the first break. There is a cell-like structure with light-coloured walls or boundaries. In places the change has gone further, and we get the fine cross-hatching characteristic of Fig. 3, which has been quenched below the first break. The cell-like structure has entirely disappeared. Fig. 4 has been quenched below the second break and resembles a slowly-cooled alloy, except that in the latter there are distinct traces of a eutectic structure. Fig. 5 has been cast on an iron plate, and the "schiller" structure is well developed. At 68·2 per cent. Cu the alloy is homogeneous, has a conchoidal fracture and is extremely brittle.

68·28 *to* 75 *per cent. Copper.*—Immediately the copper is increased above 68·3 per cent., the second eutectic makes its appearance. As the copper increases, the grains of $SnCu_4$ split up into bright veins and dendrites, surrounded by the eutectic. The veins and dendrites decrease and disappear at 75 per cent. Cu, where the mass is made up entirely of the eutectic. The alloys are best studied when furnace-cooled; their surfaces above 71 per cent. Cu are seen to consist of a network of dendrites or skeleton crystals resembling those seen on the surface of a pure metal. This surface structure continues right up to the copper end of the series. It was soon noticed that the internal structure of the alloys from 70 to 75 per cent. Cu showed no trace of these dendrites, and so the surfaces of several were rubbed down and polished. In each case their structure was the same as that of the centre of the alloy, which shows that these dendrites have split up and rearranged themselves after solidification, and all that remains of them is this surface structure. Casting makes the structure very minute, and about 73 per cent. Cu traces of the skeleton crystals can be seen in the centre of the ingot. They appear dark and structureless, as if they had been unable to resolve themselves into their two constituents.

75 *to* 100 *per cent. Copper.*—When 76 per cent. copper is present, two new constituents make their appearance and the alloy assumes a yellow tint. In section we find yellow grains, surrounded by a bright white border, set in the second eutectic, in which small bright white grains also occur. As the total copper is increased, the yellow grains increase, forming dendrites and skeleton crystals, the white borders and grains merge together and the eutectic decreases till at about 90 per cent. it disappears. The yellow grains become darker and darker (contain less and less tin in solid solution). The light borders diminish and disappear, about 95 per cent. leaving copper dendrites behind. These dendrites vary in composition from centre to outside, and so the centre etches a darker colour. They darken with increase of copper until 100 per cent. is reached. Casting tends to make the copper grains solidify, containing a considerable quantity of tin. In this way the eutectic can be made to disappear considerably below 90 per cent Cu. Quenching shows that the upper break corresponds to the solidification of the copper; break 2 to the solidification of the groundmass which splits up into a eutectic when branch *e* is reached. Fig. 6 contains 80 per cent. Cu furnace-cooled, whilst Fig. 7 shows the surface of the same and also that with this percentage of copper the dendrites of copper have directed the formation of the surface skeletons. Fig. 8 is the same alloy quenched below first break. The dendrites of copper are seen set in a structureless matrix. Fig. 9 is the same alloy quenched below the second break. The dendrites of copper (light, because of a different etching process) are seen, set in a fibrous matrix—the eutectic of which the formation has been faced. Fig. 10 shows the same alloy cast. As its appearance would indicate, the alloy is very tough and cuts well.

It seems clear then that branch *e* of the cooling curve is one of change in the solid, and this conclusion has been proved beyond doubt by the beautiful work of Heycock and Neville published by the Royal Society. When one considers the many and distinct different structures in the series produced by quenching at different temperatures and by reheating and then quenching, it is quite evident that the changes which take place during the cooling of an alloy of copper and tin, especially in the neighbourhood of the second eutectic, are even more numerous than those of the carbon-irons.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

CAMBRIDGE.—The Allen studentship, value 250*l.* for one year, for research in connection with medicine, mathematics, physics and chemistry, biology and geology, or moral science, will be filled up at the end of the present term. It is open to graduates under the age of twenty-eight on January 8.

Principal E. H. Griffiths, F.R.S., of Cardiff University College, has been approved for the degree of Doctor of Science.

The Rede lecture will be delivered next term by Prof. Osborne Reynolds, F.R.S., of Owens College, Manchester.

Mr. W. N. Shaw, F.R.S., will give three lectures, on February 13, 20 and 27, on the physics of the ventilation of buildings.

Prof. Tilden, F.R.S., has been appointed an elector to the chair of chemistry; Lord Rayleigh, F.R.S., an elector to the chairs of chemistry and of mechanism; Dr. Hill, to the anatomy chair; Mr. F. Darwin, F.R.S., to the botany chair; Dr. Hinde, F.R.S., to the geology chair (Woodwardian); Sir G. G. Stokes, F.R.S., to the Jacksonian and Cavendish chairs; Dr. D. MacAlister, to the Downing chair of medicine; Dr. Hugo Müller, F.R.S., to the chair of mineralogy; Prof. E. Ray Lankester, F.R.S., to the chair of zoology and comparative anatomy; Prof. McKendrick, F.R.S., to the chair of physiology; Lord Lister, F.R.S., to the chair of pathology; and Prof. Marshall Ward, F.R.S., to the chair of agriculture.

Dr. J. Reynolds Green, F.R.S., has been elected to a fellowship at Downing College.

THE University College, Bristol, does not receive the generous support given to similar colleges elsewhere, but the report of the council for the session 1900–01 shows that much valuable work has been done in spite of limited means and opportunities. Important papers have been published by various members of the scientific staff and others are in progress. The clinical and bacteriological research laboratory, which has been at work under Prof. Stanley Kent for little more than a year, has, among other matters, been able to afford valuable aid to the Medical Officer of Health in reporting upon the presence of plague in-

fection in material submitted for examination. In one case, plague infection was found to be undoubtedly present, and the report of the laboratory upon it was made immediately. In a second case the appearances presented were suspicious, and the report of the laboratory enabled precautions to be taken to safeguard the city in the event of true plague appearing. More accommodation for this kind of research work is required, as there is no lack of persons willing to undertake it. The same remark applies to other departments of the College. If people of means in Bristol and the neighbourhood took any interest in educational progress, the establishment of the University of Birmingham, and the movement in favour of other universities of a similar kind, would inspire them to action in the same direction. There is room for a University of the West of England, and if Bristol does not rise to its opportunity another city of the west will take its place. The subject has been brought up over and over again, and only a few days ago Mr. Haldane spoke in favour of it at the annual dinner of the University College Colston Society. The Bishop of Hereford also alludes to it at the end of the present report. But the rich citizens of Bristol do not seem to understand what has been done by private persons for higher education in cities like Liverpool, Birmingham and Manchester, or if they know they apparently have no desire to follow the example. There will have to be a complete awakening of the spirit of pride in local resources for education and research before Bristol can make any real movement towards a University of the West of England.

SCIENTIFIC SERIALS.

Transactions of the American Mathematical Society, vol. iii. No. 1, January.—On a class of automorphic functions, by J. L. Hutchinson. In Burkhardt's "Ueber die darstellung einiger fälle der automorphen primformen durch Specielle Thetareihen," the following monodromy group of the Riemann surface, $y^3 = (x-\alpha_1)(x-\alpha_2)(x-\beta_1)^2(x-\beta_2)^2$, is considered, and he shows how a certain prime form which is automorphic for the group can be expressed by a theta series. Further results are here given concerning the group and the functions belonging to it, the chief object being to obtain explicit analytic formulæ by means of which all functions of the group can be represented. To this end the theta-fuchsian functions of Poincaré are introduced, and their expressions in terms of the hyperelliptic theta series deduced.—Concerning the existence of surfaces capable of conformal representation upon the plane in such a manner that geodetic lines are represented by a prescribed system of curves, by H. F. Stecker, is in continuation of a previous paper under nearly the same title (vol. ii. p. 152).—Zur erklärung der Bogenlänge und der inhaltes einer Krummen fläche, by O. Stoll (*cf.* the author's "Grundzüge der Differential- und Integralrechnung," Bd. 2, and *Math. Ann.*, Bd. 18).—The groups of Steiner in problems of contact, by Dr. L. E. Dickson, gives an elementary proof of Jordan's ("Traité," pp. 229–249). Reference is given to Steiner and Hesse (*Journal für Math.*, vol. xlix. (1855) and vol. lxiii. (1864), and to papers by the author (*Bulletin* Amer. Math. Soc., vol. iv., and the *American Journal of Mathematics*, vol. xxiii. pp. 337–377).—Quaternion space, by A. S. Hathaway, follows up Stringham's work in vol. ii. p. 183, but frequent reference is made to Clifford's paper on biquaternions. Stringham deals analytically with the equations of loci and develops the geometry by the interpretation of those equations; the author uses a more synthetic method, which interprets the quaternion symbols themselves instead of the equations between them. It is this divergence which constitutes the general difference between the methods of Cayley and Tait. Clifford stated the synthetic view in his Further note on biquaternions.—Reciprocal systems of linear differential equations, by E. J. Wilczynski, arrives at interesting results in connection with previous papers (*Transactions*, vol. ii. No. 4; *American Journal of Mathematics*, vol. xxiii.).—On the invariants of quadratic differential forms, by C. N. Haskins, investigates, by means of Lie's theory of continuous groups, the problem of determining the number of invariants of the general quadratic form in n variables. Numerous references occur in the paper.—On the nature and use of the functions employed in the recognition of quadratic residues, by Dr. E. McClintock, refers to Tannery, "Leçons d'Arithmétique," Bachmann, "Elemente der Zahlentheorie," and to Baumgart, "Ueber der Quadratische Reciprocitätsgezetz."—A determination of the number of real and imaginary roots of the hypergeometric series, by E. B. Van Vleck. Concisely we must refer to Klein (*Math. Ann.*, vol. xxxvii. p. 573) for the number of the roots of the equation considered between 0 and $-\infty$. Mr. Van Vleck claims that he gives, for the first time, the number of imaginary roots. Numerous references and diagrams (six and a page of sixteen) accompany the text.—The second variation of a definite integral when one end-point is variable, by G. A. Bliss. The method which the author applies to the discussion of the case in which one end-point moves on a fixed curve is closely analogous to that of Weierstrass ("Lectures on the Calculus of Variations," 1879). In the present case terms outside of the integral sign are taken into consideration. Then, as a result of the discussion, the analogue of Jacobi's criterion is derived, defining, apparently in a new way, the critical point (Kneser's "Brennpunkt") for the fixed curve along which the end-point varies. Then the relation between the critical and conjugate points is discussed.—On the projective axioms of geometry, by E. H. Moore, contains a consideration of the axioms called by Hilbert ("Grundlagen der Geometrie") the axioms of connection and of order, and by Schur ("Über die Grundlagen der Geometrie") the projective axioms of geometry. There are several citations of authorities, such as Peano, Pasch and Ingrami.

Bulletin of the American Mathematical Society, January.—Note on Mr. George Peirce's approximate construction for π, by E. Lemoine. This article gives four constructions suggested by a discussion of Mr. Peirce's which we have previously noticed (*Bulletin*, July, 1901). The relative theoretic exactness is determined by calculating the true value of the length which in each case approximately represents π. The solutions are worked out by aid of the geometrographic notation. A slight sketch of this method, sufficient for the present purpose, is given. (For a fuller account, reference may be made to M. Lemoine's "La Géométrografie" or to the "Traité de Géométrie" in the *Archiv. der Mathematik und Physik*, April and May, 1901, vol. i., Gauthier-Villars). There is also appended a close approximation to the trisection of an angle by C. Störmer worked by the same method. There are several diagrams.—Concerning the elliptic $\wp\,(g_2, g_3, z)$ functions as coordinates in a line complex, and certain related theorems, by Dr. H. F. Stecker, is an application of the coordinates to the Kummer surface and certain other configurations (*cf.* Klein, *Math. Ann.* vol. v., pp. 294–5).—A short note on the Abelian groups which are conformal with non-Abelian groups follows, by Dr. G. A. Miller. Dr. S. E. Slocum writes on the infinitesimal generators of certain parameter groups. The paper opens with a *résumé* of the method employed by the author on pp. 97–103 of the *Proceedings* of the American Academy of Arts and Sciences, vol. xxxvi., and then proceeds to give tables in which are enumerated all possible types of structure of two-, three- and four-parameter complex groups as given by Lie, and under each structure are given the symbols of the infinitesimal transformations which generate the parameter group corresponding to that structure, obtained by the method referred to above (*cf.* Lie, "Continuierliche Gruppen," pp. 565–589; "Transformations Gruppen," vol. iii., pp. 713–730).—Notices follow of the "Einführung in die Theorie der Differential gleichungen mit einer unabhängigen Variabeln" of Dr. L. Schlesinger and of Prof. Hatzidakis's "εἰσαγωγὴ εἰς τὴν 'Ανωτέραν 'Αλγέβραν."—The usual information of interest to mathematicians follows in the form of notes and new publications.

Annals of Mathematics, January.—Some applications of the method of abridged notation, by Maxime Bôcher, is an interesting elementary paper the nature of which may be gathered from an illustration. Let the sides of a triangle be $u=0$, $v=0$, $w=0$ (where $u \equiv x\cos\alpha + y\sin\alpha - p$), then $u-v=0$, $v-w=0$, $w-u=0$ are the bisectors of the angles, and as the sum of the sinisters vanishes identically we get the property of the bisectors of the angles cointersecting in a point. If, again, $u \equiv x^2+y^2+ax+by+c=0$ and so on, we can show that the common chords of three circles meet in a point. The author then proceeds to the proof of Desargues' theorem and thence to generalisations for four circles and for curves of the nth order, and extends, by suggestion, his results to surfaces.—On the roots of functions connected by a linear recurrent relation of the second order, by M. B. Porter, reproduces in part some unpublished theorems of Sturm (*cf.* "Liouville," vol. i.), and shows how, by means of the Cauchy-Lipschitz theorem for the existence of solutions of a differential equation, it is possible to establish

rigorously the analogous theorems, so far as they exist, for the homogeneous linear differential equations of the second order. The article closes with some applications.—Space of constant curvature, by F. S. Woods, is an attempt to present Riemann's ideas (*cf.* the "Ueber die Hypothesen, welche der Geometrie zu Grunde liegen") in an elementary form. The paper is given in part and is useful, in addition to the results worked out, for its bibliographical references.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, January 23.—"The Affinity of Tmesipteris with the Sphenophyllales." By A. P. W. Thomas, M.A., F.L.S., University College, Auckland, New Zealand.

In the present paper the author deals with the nature of the synangium of Tmesipteris, as based on the study of variations observed in the sporophyll, beyond the limits already recorded by Bower.

The term "sporophyll" is used to denote the whole fertile structure, the term "synangium" restricted to the sporangiophore. Three types of variation are recorded, viz. (1) that of repeated dichotomy of the sporophyll with two to three synangia; (2) that in which the synangium is raised upon a pedicel or stalk; (3) that in which the synangium is replaced by a leaf-lobe of normal appearance. It is shown that abnormality in the sporophylls and synangia, which commonly occurs at the beginnings or ends of the fertile zones, is not found in cases where the sporophyll shows excessive leaf development. In these it occurs rather towards the middle region, and it is inferred that if the nutritive conditions remained equally satisfactory throughout, the whole sporophyll series should show repeated dichotomy.

Concerning the second type of variation, the synangium is found to have become so revolved upon a transverse axis that its longitudinal groove faces outwards between the leaf-lobes, assuming a position the more favourable to dispersal of the spores. In the third type the leaf is shown to be forked, although the synangium, if present at all, exists only in an abortive form. From the fuller study of this, the author suggests that the synangium is the morphological equivalent of a ventral leaf-lobe.

Passing to questions of classification, the author refers to the difficulties in reconciling the sporangium-bearing structures of the Psilotæ with those of the typical Lycopodinæ. He enters into a comparison with the extinct Sphenophyllales, with especial reference to Bowmanites and Cheirostrobus, and concludes that the relationships of Tmesipteris and Psilotum with this group are perhaps even closer than is supposed by Scott.

In an addendum, received since this paper was announced, the author makes good his desire to deal extensively with the Psilotum sporophyll, the leaves of which, though greatly reduced and xerophytic, are shown to be essentially similar to those of Tmesipteris.

Society for Psychical Research, January 31.—Dr Oliver Lodge, F.R.S., delivered his presidential address. Dealing first with the phenomena of trance, lucidity and clairvoyance, he expressed the opinion that much more information was required before we could even formulate the problems raised by these faculties. With regard to physical phenomena, he thought much of the extra difficulty of accepting evidence for unusual phenomena was due to the *a priori* notion that such occurrences are contrary to natural law. We cannot, however, clearly tell that they are contrary to natural law; they are only contrary to and supplementary to our usual experience. The objection of science to psychical research is mainly due to the fact that it regards psychical phenomena as unintelligible. It is accustomed to simplify its problems by the method of abstraction and has got into the habit of thinking that it actually excludes disturbing causes; the abstraction cannot really exclude from the universe anything apparently disorderly. Theoretically, this is universally admitted; practically science has excluded psychical phenomena from its experimental area. He was not prepared to say that physical phenomena such as materialisations, the passage of matter through matter, and levitation were impossible and absurd, so that no testimony ought to produce any effect on our incredulity. Extreme caution was necessary and full control must be allowed to the observers. His personal belief was that man survived death, and this belief had been produced by scientific evidence. He did not attribute the physical phenomena of spiritualism to the agency of the departed, but was disposed to regard trance utterances as in some cases due to telepathic communication with some unconscious stratum of a departed person.

Royal Microscopical Society, January 15.—Mr. Wm. Carruthers, F.R.S., president, in the chair.—This being the annual meeting of the Society, the president gave an address on the scientific work of Nehemiah Grew, from 1641–1712, whom he defended from the charges of plagiarism which had been brought against him in respect to his discoveries as to plant structure.—Mr. E. A. Parsons gave an exhibition of malaria parasites under a number of microscopes, lent for the occasion by Messrs. Chas. Baker.—Messrs. Ross exhibited their new form of standard microscope, designed specially for the use of medical students, fitted with a new form of fine adjustment. Messrs. Ross also exhibited a simple lens for dark ground illumination. It consists of a meniscus lens bored through its centre to receive a spot made of vulcanite provided with a stem to drop into the hole in the centre of the lens.

Geological Society, January 22.—Mr. J. J. H. Teall, V.P.R.S., president, in the chair.—The fossiliferous Silurian beds and associated igneous rocks of the Clogher Head district (county Kerry), by Prof. S. H. Reynolds and Mr. C. I. Gardiner. The authors give a detailed description of the coast from Dunquin past Clogher Head to Coosglass (south of Sybil Point), and of the western side of Smerwick Harbour. They next deal with the inland exposures, which are not very frequent, but include considerable rock-masses at Croaghmarhin and Minaunmore Rock. The rocks consist of sandstones, slates, calcareous flags, ashes and ashy conglomerates, rhyolitic lava-flows and various intrusive rocks. The general structure is an S-shaped fold, inverted towards the north so that the dip of the beds is approximately south-easterly, and the oldest beds occur to the north, at Coosglass. Both anticline and syncline are faulted, and a patch of Old Red Sandstone is caught in under the synclinal thrust at Coosmore. Fossils, mainly corals, brachiopods, lamellibranchs and gasteropods are fairly abundant; but trilobites are rare and graptolites absent. The whole of the fossiliferous rocks are of Silurian age; the majority of those exposed on the coast are of Wenlock or Wenlock-Llandovery age, while the majority of those exposed inland are of Ludlow age.—A process for the mineral analysis of rocks, by Prof. W. J. Sollas, F.R.S. The method proposed is to obtain a quantitative estimation of the mineral composition of a rock, and from the known composition of the minerals to calculate the percentage-composition of the rock. The specific gravities of the minerals are first determined by means of a diffusion-column of methylene-iodide and beads of known specific gravity, and the presence or absence of particular minerals settled for a certainty. Next, the separation of the minerals in a weighed quantity of the powdered rock is undertaken by means of a special separator, the method being illustrated by the example of a rock containing orthoclase (sp. gr. 2·56), quartz (2·65), andesine (2·67), biotite (3·1), pyroxene (3·3) and magnetite. The first separation would be with a liquid of sp. gr. 2·885, the mean of that of andesine and biotite; the next with a liquid of sp. gr. 2·66; the next 2·605, and so on for the other constituents. The separated minerals are dried and weighed, the loss distributed, and the analysis checked by comparing the specific gravity of the rock in bulk with that calculated from the specific gravity and proportion by weight of its constituents.

DUBLIN.

Royal Irish Academy, January 13.—Prof. R. Atkinson, president, in the chair.—Prof. T. Johnson communicated, on behalf of the fauna and flora committee of the Royal Irish Academy, a paper by Mr. W. West and Prof. G. S. West entitled "A Contribution to the Freshwater Algæ of the North of Ireland." This paper gives the results of the examination of material collected by the authors in 1900 and 1901 in Lough Neagh and district, and in co. Donegal. 139 genera, 604 species and 106 varieties are recorded. Of these some twelve, described and illustrated, have been hitherto unknown, twenty-four others are new to the British Isles, many others new to Ireland, and the distribution of yet others, recorded by the late Mr. W. Archer, F.R.S., and Rev. E. O'Meara, is largel

extended. The paper is illustrated by some ninety figures. Three desmids, *Micrasterias furcata*, Ag., *Staurastrum Arctiscon* (Ehrenb.), Lund., and *Staurastrum longispinum* (Bail.), Arch., are of particular interest in that they appear to be confined to the western shores of the British Isles—being known only as occurring in the small lakes in the hilly districts of Connemara and Donegal in Ireland, the lakes of the Snowdon range in North Wales, and from similar situations in the extreme north-west of Scotland. No species of Vaucheria were found, and *Botrydium granulatum* is recorded for the first time in Ireland.

Royal Dublin Society, December 18, 1901.—Dr. W. E. Adeney in the chair.—Sir Howard Grubb, F.R.S., on some new forms of geodetical instruments. The author applies the principle he recently described (*Scientific Transactions*, Royal Dublin Society, vol. vii. p. 321) for gun sights for large and small ordance to various forms of geodetical instruments.—Prof. J. Joly, F.R.S., on sedimentation experiments and theories. T he rates of settlement of suspensions consisting of 5 grammes of finely powdered solid in 12 c.c. of water containing ions in various degrees of concentration, indicate that above a certain concentration the rate of fall of the surface of the suspension is fairly independent of the degree of concentration. Below certain concentrations (about five times greater for monad positive ions than for diad) a distinct surface to the descending suspension fails, and the sediment is only seen to collect from the bottom of the vessel upwards. A suspension precipitated at a concentration so low as to be near the point of failure to show surface will, if re-shaken, not again precipitate with a distinct surface. On removing the electrolyte from such an "exhausted" suspension after it has stood sufficiently long to settle, it is found that the liquid is as effective as at first in producing surface if a fresh sample of the powder is used. On the other hand, the original powder will not again show surface when treated with fresh electrolyte of the same strength, but it will require a much more concentrated electrolyte to do so. The failure is therefore to be traced to some alteration in the solid particles. On testing the fresh powder it is found that this is negative towards distilled water; the used powder is apparently quite neutral towards its salt solution. An explanation of sedimentation is advanced, based on the low specific inductive capacity of the solid particle compared with the specific inductive capacity of the water, the charges on the ions being assumed to exert an expulsive action consequent on the increased energy required to establish the electric field in the medium of low specific inductive capacity. In other words, the solid particles have a de-ionising influence, and experience a reaction in consequence, which will tend to retain in juxtaposition particles which from any cause are once approximated. A principal cause of aggregation upon first precipitation is to be ascribed to the negative sign of the particles leading to motions, all in the end favourable to aggregation, seeing that the state of aggregation is alone stable in the medium. On second disturbance the particles are neutral, and aggregates are not formed with sufficient rapidity to lead to a general and simultaneous descent of the suspension.—Lord Rosse, K.P., F.R.S., exhibited working models of apparatus for turning aside leaves in the water supply of a turbine.—Sir Howard Grubb exhibited the cœlostat constructed for the Royal Dublin Society and used at the solar eclipse of 1900.

January 22.—Prof. W. F. Barrett, F.R.S., in the chair.—Mr. W. E. Wilson, F.R.S., on the nebulæ surrounding Nova Persei.—Prof. Barrett, Mr. W. Brown and Mr. R. A. Hadfield, on researches on the electric properties of an extensive series of alloys of iron.—Mr. Richard J. Moss, on an improved volumetric method for the determination of sugar. In Pavy's modification of Fehling's method, cupric oxide is reduced in presence of a a large excess of ammonia, which prevents the precipitation of cuprous oxide. The temperature of the boiling liquid varies from about 70° C. to 90° C., and the rate of reduction varies to a corresponding extent. The author overcomes this objection to the method by using a much smaller quantity of ammonia, and conducting the titration under pressure, at the temperature of boiling water. The reduction of the cupric oxide is apparently instantaneous, and the results are very sharp and constant.

PARIS.

Academy of Sciences, February 3.—M. Bouquet de la Grye in the chair.—On a new synthesis of formic acid, by M. Henri Moissan. Potassium hydride absorbs carbonic acid at the ordinary temperatures producing potassium formate. The formation of formic acid was confirmed by the production of the free acid, which showed the ordinary reducing properties, and by the preparation and analysis of the crystallised lead salt. Carbon monoxide also reacts with potassium hydride at 150° C., potassium formate being formed and carbon set free.—On certain cases of adherence of a viscous liquid to the solid with which it is in contact, by M. P. Duhem. —New observations on the folds of the phosphatic chalk in the Somme, by M. J. Gosselet. The strongly inclined layers of phosphatic chalk discovered at Éaves in 1896 might have been looked upon as a local accident, but the same facts have now been noticed at Hargicourt, and at two places at a much greater distance, Éclusier, between Peronne and Albert, and at Crécy in Ponthieu. These layers are small, but are too widely extended to be the result of a purely local accident. The facts observed confirm the views of M. Marcel Bertrand on the slow and progressive formation of the folds of a geological basin.—Remarks by M. Albert Gaudry on presenting to the Academy a work on the comparison of the teeth of man and the anthropomorphic apes.—M. Alfred Picard was elected a free member in the place of the late M. de Jonquières.—Observations of the sun made at the Observatory of Lyons with the Brunner 16 cm. equatorial during the second quarter of 1901, by M. J. Guillaume. Tables are given showing the number of spots, their distribution in latitude and the distribution of the faculæ in latitude.—Researches on the Hertzian waves emanating from the sun, by M. Charles Nordmann. The experiments described were carried out at the Grand-Mulets on Mt. Blanc, the weather conditions being too unfavourable to utilise the observatory at the summit. The conclusions drawn from the experiments are that the sun does not emit electric radiations capable of affecting radioconductors, or that, if they are given off, they are completely absorbed by its atmosphere or by the upper portions of the terrestrial atmosphere.—Some remarks on entire functions, by M. Edmond Maillet.—The variation of the electromotive force and the temperature coefficient of the Daniell cell with the concentration of the zinc sulphate solution, by M. J. Chaudier. Starting with a saturated solution, the electromotive force of a Daniell cell increases when the concentration of the zinc sulphate diminishes, passes through a maximum for a $\frac{1}{2}$ per cent. solution, and then again decreases for smaller concentrations. The temperature coefficient, which at first is negative, increases and becomes zero at a concentration of between 7 and 8 per cent.; but, after having attained a positive maximum, it falls off and vanishes a second time for a $\frac{1}{2}$ per cent. solution. From this it follows that the Daniell cell furnishes a standard of electromotive force which is independent of the temperature when it is made up with a saturated solution of copper sulphate and a 7·5 per cent. or $\frac{1}{2}$ per cent. solution of zinc sulphate.—On the galvanometric observation of distant storms, by M. J. J. Landerer. With the arrangement described the electrical disturbances due to distant storms have been observed up to a distance of 240 kilometres.—Comparison between the properties of hydrogen selenide and those of hydrogen sulphide, by MM. de Forcrand and Fonzes-Diacon. Data for hydrogen sulphide are given in the present paper. The boiling-point at a pressure of 773 mm. was found to be −61° C., and the melting-point −86° C. The density of liquid sulphuretted hydrogen at its boiling point is 0·86. A comparison with the data previously given for hydrogen selenide shows great analogies between the two compounds They have practically identical molecular volumes, their boiling-points expressed as fractions of their critical temperatures are the same, and the ratio of latent heat of vaporisation to the boiling-point is also nearly the same for the two gases.—On the action of lithium-ammonium on antimony, and on the properties of the antimonide of lithium, by M. P. Lebeau. Lithium-ammonium reacts upon antimony, giving a compound of the formula $SbLi_3$, identical with that previously obtained by electrolysis. This substance dissolves in liquid ammonia, uniting with it to form the compound $SbLi_3NH_3$. Lithium antimonide is less fusible than either of its constituents, and possesses very energetic reducing properties.—On oxy-isopropyl-hypophosphorous acid, by M C. Marie.—On the hydrolysis of pyromucic urethane, by M. R. Marquis.—The action of nitric acid upon trichloro- and tribromo-veratrol, by M. H. Cousin. The action of nitric acid upon these substituted veratrols gives rise to mono-nitro-derivatives, the reaction being altogether different from the action of nitric acid upon the tetra-chloro- and tetra-

bromo-veratrols.—On some derivatives of glutamine, by M. E. Roux. A description of the mode of preparation and properties of various derivatives of glucamine.—The action of aluminium chloride on some anhydrides in chloroform solution, by M. Marcel Desfontaines.—On the opisthobranchs collected in 1883 by the Talisman expedition, by M. A. Vayssière.—The lymphomyeloid constitution of the conjuctive stroma of the testicle of the young in *Raja clavata*, by M. A. Policard.—On the homologies of the interstitial cell of the testicle, by M. P. Stéphan.—On the structure of the tuberculous roots of *Thrincia tuberosa*, by MM. A. Maige and C. L. Gatin.—On the *Ksopo* or *Tanghin de Ménabé*, the poison of *Menabea venenata*, by M. E. Perrot.—The chemical study of Flamanville granite, by M. A. Leclère. It is shown from the analyses given that the composition of an eruptive rock may differ very considerably in certain cases from that of the initial magma.—On the transformation of fatty materials into sugars in oleaginous seeds during germination, by M. P. Mazé. The experiments afford confirmation of the view that the digestion of fatty matters in the seed during germination is made with a slow fixation of oxygen, and, probably, with a slight loss of carbon.—Researches on the working of antagonistic muscles in voluntary movements, by M. I. Athanasiu.—Remarks on a note of M. Pizon on a mechanical theory of vision, by M. Raphael Dubois. In reply to the criticism of M. Pizon, the author maintains that his mechanical theory of vision is confirmed, not only by the researches of Deren Stort and Engehlmann, but also by those of Charpentier and d'Arsonval.—The vine and *Coepophagus echinopus*, by M. S. Jourdain. MM. L. Mangin and P. Viala have correlated a certain disease of the vine with the presence of a certain acarian, *C. echinopus*. The author advances reasons for doubting the correctness of this view, and believes that curative measures directed against this acarian will be useless.—A new case of trichosporia observed at Nancy, by M. Paul Vuillemin.—Contribution to the knowledge of the action of lecithine on the typical elements of the blood, by MM. H. Stassano and F. Billon.—The etiology of the cattle plague, by MM. Nicolle and Adil-Bey.—On a fall of rain observed at Périers, by M. Sebillaut. The rain-water from the shower in question was found to contain chalk, sulphates, chlorides and silica, the latter in sufficient quantity to cover the leaves of trees with a siliceous layer.

DIARY OF SOCIETIES.

THURSDAY, FEBRUARY 13.

ROYAL SOCIETY, at 4.30.—On the Sub-Mechanics of the Universe: Prof. O. Reynolds, F.R.S.—On Chemical Dynamics and Statics in Light: Dr. M. Wilderman.—Preliminary Note on a Method of Calculating Solubilities, Equilibrium Constants of Chemical Reactions, and Latent Heat of Vaporisation: Dr. A. Findlay.—The Refractive Indices of Fluorite, Quartz and Calcite: J. W. Gifford.

INSTITUTION OF ELECTRICAL ENGINEERS, at 8.—Researches on the Electrical Conductivity and Magnetic Properties of upwards of 100 different Alloys of Iron: Prof. W. F. Barrett, F.R.S., and W. Brown.—On some Conclusions deduced from the preceding Paper: Prof. W. F. Barrett, F.R.S.

MATHEMATICAL SOCIETY, at 5.30.—(1) On the Density of Linear Sets of Points; (2) On Closed Sets of Points defined as the Limit of a Sequence of Sets of Points: W. H. Young.—On Plane Cubics: Prof. A. C. Dixon.—On Boussinesq's Problem: Prof. H. Lamb, F.R.S.—On the Wave Surface of a Dynamical Medium, Æolotropic in all Respects: Prof. T. J. Bromwich.—On Quantitative Substitutional Analysis (second paper): A. Young.

FRIDAY, FEBRUARY 14.

ROYAL INSTITUTION, at 9.—Magic Squares and other Problems on a Chess Board: Major P. A. MacMahon, F.R.S.

PHYSICAL SOCIETY, at 5.—Annual General Meeting.—Address by the President, Prof. S. P. Thompson, F.R.S.—Mr. T. H. Littlewood will exhibit an Atwood's Machine.

ROYAL ASTRONOMICAL SOCIETY, at 3.—Annual General Meeting.

MALACOLOGICAL SOCIETY, at 8.

INSTITUTION OF CIVIL ENGINEERS, at 8.—Some Public Health Aspects of the Question of Sewage Disposal: C. Johnston.

SATURDAY, FEBRUARY 15.

ROYAL INSTITUTION, at 3.—Some Electrical Developments: Lord Rayleigh, F.R.S.

MONDAY, FEBRUARY 17.

SOCIETY OF ARTS, at 8.—Personal Jewellery from Prehistoric Times: Cyril Davenport.

IMPERIAL INSTITUTE, at 8.30.—The Obstacles to Development in West Africa: Dr. C. F. Harford-Battersby.

VICTORIA INSTITUTE, at 4.30.—The Physical History of the Norwegian Fjords: Prof. Edward Hull, LL.D., F.R.S.

TUESDAY, FEBRUARY 18.

ROYAL INSTITUTION, at 3.—The Cell: its Means of Offence and Defence: Dr. A. Macfadyen.

ZOOLOGICAL SOCIETY, at 8.30.—On *Mustela palaeattica* from the Upper Miocene of Pikermi and Samos: Dr. C. I. Forsyth Major.—On Two New Genera of Rodents from Potosi, Bolivia: Oldfield Thomas, F.R.S.—On some Characters distinguishing the Young of various Species of Polypterus: G. A. Boulenger, F.R.S.

INSTITUTION OF CIVIL ENGINEERS, at 8.—Electrical Traction on Railways: W. M. Mordey and B. M. Jenkin.

ROYAL STATISTICAL SOCIETY, at 5.—A Statistical Review of the Income and Wealth of British India: J. Atkinson.

WEDNESDAY, FEBRUARY 19.

SOCIETY OF ARTS, at 8.—The Use of Balloons in War: E. H. S. Bruce.

ROYAL METEOROLOGICAL SOCIETY, at 7.30.—Report on the Phenological Observations for 1901: E. Mawley.—La Lune mange les Nuages—a Note on the Thermal Relations of Floating Clouds: W. N. Shaw, F.R.S.

CHEMICAL SOCIETY, at 5.30.—Enzyme Action: A. J. Brown.—On the Velocity of Hydrolysis of Starch by Diastase, with some Remarks on Enzyme Action: H. T. Brown and T. A. Glendinning.—Polymerisation Products from Diazoacetic Ester: O. Silberrad.—Condensation of Phenols with Esters of Unsaturated Acids, Part VII.: S. Ruhemann and H. E. Stapleton.—The Union of Hydrogen and Oxygen: H. B. Baker.

ROYAL MICROSCOPICAL SOCIETY, at 8.—Polarising with the Microscope: E. M. Nelson.

THURSDAY, FEBRUARY 20.

ROYAL SOCIETY, at 4.30.

LINNEAN SOCIETY, at 8.—(1) On some Gasteropoda (*Limnotrochus* and *Chitra*) from Lake Tanganyika, with the Description of a New Genus; (2) On the Nyassa Vivipara and its Relationship to Neothauma: Miss L. Digby.—On the Fruit of *Melocarina bambusoides*, an Exalbuminous Grass: Dr. A. Stapf.—On a West Indian Sea Anemone, *Bunodeopsis globulifera*: Dr. J. E. Duerden.

FRIDAY, FEBRUARY 21.

ROYAL INSTITUTION, at 9.—Musical and Talking Electric Arcs: W. Duddell.

INSTITUTION OF MECHANICAL ENGINEERS, at 8.—Annual General Meeting. Followed by discussion on Modern Machine Methods, with Reply by the Author, H. L. F. Orcutt, and, time permitting, Fencing of Steam- and Gas-Engines: H. D. Marshall.—Fencing or Guarding Machinery used in Textile Factories: S. R. Platt.—Protection of Lift-Shafts, and Safety Devices in connection with Lift-Doors and Controlling Gear: H. C. Walker.—Guarding Machine Tools: W. H. Johnson.

GEOLOGICAL SOCIETY, at 3.—Annual General Meeting.

EPIDEMIOLOGICAL SOCIETY, at 8.30.

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THURSDAY, FEBRUARY 20, 1902.

PLANARIANS AND THEIR ALLIES.

A Treatise on Zoology. Edited by E. Ray Lankester, M.A., LL.D., F.R.S. Part IV. "The Platyhelmia, Mesozoa and Nemertini." By Prof. W. Blaxland Benham, M.A., University of Otago, New Zealand. Pp. iv + 204. (London: A. and C. Black.) Cloth, 15*s.* net; paper covers, 12*s.* 6*d.* net.

IT is a new thing for a whole volume of a zoological treatise to be devoted to the two phyla, Platyhelmia (Turbellaria, liver-flukes and tapeworms) and the Nemertea (long sea-worms), which Prof. Benham describes in the work before us. For a number of reasons they are not popular groups of animals. The free-living forms are delicate and their very identification is attended with considerable difficulty, and needs mechanical skill and anatomical knowledge. The parasitic forms add gruesome associations to these troubles, so that it is only the unfortunate patient, the doctor and the scientific agriculturist who have in any sense a working acquaintance with flukes and tapeworms. Very few zoologists know much about them except in such places as Italy, parts of Germany and Egypt, where their unpleasantly common occurrence has created the necessity for a thorough investigation of the modes of infection and of the methods for obtaining immunity from their attacks. Hence it is that in most text-books these phyla have not been given that serious and thorough attention which is afforded them in Prof. Ray Lankester's "Treatise of Zoology." We have here a compact, lucid and scholarly summary of the anatomy, life-histories and classification of the parasitic flatworms.

With such an unprecedented amount of room at his disposal Prof. Benham would have done well to have brought his opening chapter (on the Turbellaria or Planarians) more up to date in its anatomical, physiological and bionomical aspects. It was written and has been in proof some years, as the editor tells us, but we cannot accept the soothing remark that "the editor is satisfied that no important omissions due to this fact occur in the book." Von Graff's splendid monograph on land-planarians (1899) is barely alluded to, and his striking results on the anatomy and distribution of these animals are omitted, nor are any of his figures introduced. The work by Hesse on the eyes of Turbellaria is merely mentioned, but his important results are passed over in silence. The paper by Dörler (1900) on parasitic Vorticidæ, in many ways a striking piece of work, is entirely overlooked. The application, by Rina Monti, of the "Golgi-method" to the detection of nerve-elements of Planarians (1896, 1900), the work by Prof. E. L. Mark on Polychærus (1892 !), the many papers by the school of comparative physiologists and more particularly by Parker and by Prof. Loeb, are a few of the more striking omissions which occur to us. In some of these cases we may excuse Prof. Benham (but not his editor), since his residence in New Zealand may preclude access to the "Zoologische Jahresberichte" of the last four years; but even this allowance cannot cover the lack of information on topics such as colour, distribution and variation, upon which the evidence yielded by Turbellaria is not inconsiderable and is of great and growing interest.

The chapters succeeding that on the Turbellaria are far more satisfactory, though there are several omissions of important or useful papers, such as Looss' work on Egyptian Trematodes and the publications by Dr. Stiles and other members of the Washington Bureau on the parasites of domestic animals. To the student of anatomical zoology the sections on the "cuticle," "parenchyma," and the life-histories and their interpretation, will be a clearer guide to the nature of these problems than can be found in any other text-book.

As to the nature of the cuticle or investing membrane of Trematodes and Cestodes, Prof. Benham concludes from the researches of Blochmann and Kowalewski that the outer part of this structure is a true cuticle secreted by epidermal cells. In the adult parasite, however, these cells no longer form an epithelium, and their true nature is further disguised by the fact that they lose their primitive connection with the cuticle and sink into the parenchyma through the basement-membrane *pari passu* with an outward migration of cells of the parenchyma. These changes are illustrated by an excellent figure from Blochmann's memoir.

From an economic as well as from a strictly zoological standpoint, the interest of Trematodes and Cestodes centres in the life-history, which becomes progressively complicated in each group. There may be in the history of one parasite two successive larval stages passed in different hosts. Each stage is capable of reproducing many generations of its kind and then suddenly giving rise to the later larval form or (in the case of the latter) to the adolescent stage, which grows to maturity in the final host. The distinguishing feature of the process is the power of multiplication of the parasite while it is still a larva, and it is on the nature of this process that difference of opinion exists. The older writers regarded it as an asexual mode of reproduction, as a kind of budding; and they emphasised the alternation of these larval asexual generations with the adult sexual generation. The tendency of modern research has been to regard the larval generations, not as asexual, but as produced by the development of unfertilised eggs, in fact as cases of juvenile parthenogenesis; so that the life-history may on this view be summarised as a series of sexual generations, of which those which occur in the larval stages are parthenogenetic and that which subvenes in the adult worm is either self- or cross-fertilised.

To this modern view Prof. Benham assents, without, however, pointing out the necessity of obtaining critical evidence in its favour. The mature eggs of many animals differ from the body-cells in possessing only half the number of "chromosomes" which characterise the nuclei of the somatic-cells. It ought to be shown whether this holds true of the larval as well as of the adult "eggs" of Trematodes and Cestodes before the view that all the generations are sexual can be considered proved, and it would require still further evidence as to the number of the polar-bodies presumably extruded by the larval eggs before we could accept their parthenogenetic nature as demonstrated.

The concluding chapters on the Mesozoa and Nemertea

have been carefully brought up to date. They furnish a trustworthy account of the essential facts of anatomy and development, but as occurs in the case of the other groups described in this volume, the problem of their affinities is not set forth with that clearness which is so essential to its comprehension.

Considered as a whole, the volume has not that illuminating and suggestive value which distinguished the earlier volumes of the "Treatise." Nevertheless it will remain for some time the chief work of reference in the language on the anatomy and classification of the groups with which it deals.

PRIMARY BATTERIES.

Primary Batteries: their Theory, Construction and Use. By W. R. Cooper. Pp. 4+324. (London: *The Electrician* Printing and Publishing Co., Ltd., no date.) Price 10*s*. 6*d*. net.

MR. W. R. COOPER'S book directs attention to a subject which will always be of great historical interest on account of the remarkable stimulus given to electrical science by the discoveries of Galvani and Volta. At the present time, it is true, the primary battery has yielded to cheaper and more convenient sources of electrical energy, and the position which it holds in electrical engineering is comparatively insignificant. It is not improbable that before long it will be displaced from almost all practical applications of electricity and will only be found where the dynamo and accumulator are unavailable. It may, however, be some consolation to those who have not other means at hand to reflect that in the research by which Faraday laid down the fundamental laws of electrolysis he obtained current from a primary battery of the most elementary form. The advantage of amalgamating the zinc had been shown five years earlier (1828) by Kemp, but it was not until 1836 that the first effective depolarising cell, that of Daniell, was described; the invention of the Grove cell followed in 1839. The Leclanché cell, which did not appear until 1868, marks the only other development of the first importance.

In spite of the fact that Volta's discovery is more than a century old, the theory of the primary battery cannot be said to be in a very satisfactory state. Mr. Cooper devotes two chapters to this subject, the first of which deals chiefly with contact-force and the seat of the E.M.F. in the cell. Mr. Cooper, in summing up the various theories, states that "the whole matter (of the seat of the E.M.F.) is largely a question of definition, and is, therefore, of relatively small importance," a conclusion which is not likely to commend itself to those who are anxious to arrive at the truth. In the second chapter, the ionisation theory of Arrhenius is discussed and the calculations of the E.M.F. of a cell from the equations of Helmholtz and Nernst are compared, with results which are not very convincing in either case. The author then passes to a brief consideration of concentration and liquid cells (which are at present only of theoretical interest) and of the thermopile, which, he points out, on account of its high price is not likely to prove a serious competitor to the primary battery.

There follows what may be called the practical part of the book, in which the various types of existing cells are described and which contains much valuable information collected or directly obtained by the author. Cells are classified under three headings, one-fluid, two-fluid and dry cells. In the first division, the principal examples are the bichromate, Leclanché and copper-oxide cells. Some interesting tests carried out by the author show that in the bichromate cell the most suitable depolariser to use is chromic acid, which gives a discharge curve as good as that given by either sodium or potassium bichromate and is also more convenient and as cheap. The two-fluid cells include the Daniell, with its numerous derivatives, and the Grove and Bunsen cells, which on account of their high E.M.F. and low internal resistance are especially suitable where heavy currents are required. All the dry cells are modifications of the Leclanché and do not differ much from one another except in details of construction. It is somewhat surprising to find that, weight for weight, the dry cell is superior to the wet form of Leclanché. Against this must be set the somewhat higher initial cost and the advantage of the possibility of regenerating an exhausted wet cell, though this latter consideration, as Mr. Cooper shows, is in reality somewhat illusory. The usefulness of this part of the book is greatly increased by the numerous discharge curves which are included and by the many very clear drawings illustrating the various cells described.

The last two chapters deal with standard cells and carbon-consuming batteries. The standard cell is, and is likely always to remain, of the highest practical importance; the chapter dealing with it is consequently of great interest and value, as it contains in a convenient form most of the hitherto scattered information on this subject. The table of constants of standard cells shows that the results of recent determinations point to the value 1·433 volts being more nearly correct for the E.M.F. of a Clark cell at 15° C. than the generally accepted (and legal) value of 1·434 volts. The Helmholtz cell, recently modified by Hibbert, is of interest on account of its having an E.M.F. of 1 volt at 15° C. and also a very low temperature coefficient, though in this latter respect it is inferior to the cadmium cell. The final chapter, on the carbon-consuming cell, is, unfortunately, only a record of failures. It would seem as if commercial success, if ever to be achieved, will have to be sought on entirely new lines. But the problem is not likely to lose its fascination so long as the overall efficiency of steam generation remains as low as 6 per cent. whilst the primary battery holds out a prospect of the attainment of an efficiency of 73 per cent. or more.

M. S.

A MEMOIR ON MORAINES.

Geschichte der Moränenkunde. Von Dr. August Böhm Edlen von Bömersheim (*Abhandlungen der K. K. Geographischen Gesellschaft in Wien*, iii. Band, No. 4). Pp. viii+334; 4 plates, 2 figures in text. (Wien: R. Lechner, 1901.)

AS to the history of moraines, the author might fairly say "What there is to know, I know it." By patient research in libraries he has collected a great mass of information, of which the present volume is a summary. It also contains, besides the main subject, a

full account of drums or drumlins, which in some way or other are closely related to moraines, the proceedings of the Glacier Conference held at Gletsch in August, 1899, a section on the distinctions and nomenclature of moraines, a glossary and list of synonyms, and indices of authors and subjects. After answering, by quotations from writers, beginning with Sebastian Münster in 1544, the question, What is meant by a glacier? he passes on to moraines, which are at first mentioned casually, without any definite name. This does not appear till rather late in the eighteenth century, about the time of De Saussure. The word, no doubt of patois origin, was not admitted to dictionaries or encyclopedias till well on in the following century. According to Littré its origin is unknown, though it evidently is related to the Low Latin *morena*—bank of stones—which also appears in Italian under the older form, *mora*, and in Piedmontese *murena* designates earth piled in a bank by the side of a field. We also learn that in the German Alps the names *Ganda*, *Gandecken*, *Mârenes* and *Murren* are used, the last perhaps restricted to the Œtzthal district. Then follows a long series of abstracts or extracts chronologically arranged from the works of travellers by whom moraines have been noticed or described.

Before the first quarter of the nineteenth century the accounts become definite, von Charpentier in 1819 pointing out that some of the material in a terminal moraine travelled on, some under, the ice. The different varieties are clearly distinguished by F. J. Hugi in 1830, from which time the study assumes a scientific aspect, J. de Charpentier four years later clearly recognising old moraines. They began to be identified in other countries; C. Martins, in 1841, compared the glaciers of Spitzbergen and the Alps, and showed that moraines were also associated with the former. At the same time the study of everything associated with glaciers received a fresh impulse from the investigations of Agassiz, and from this date ground moraine (*grund moräne* or *moraine profonde*) begins to figure in books (though we believe he spoke only of *couche de boue*). Of this, perhaps, not so much is now heard as some quarter of a century ago, when a glacier might have assumed *Diruit*, *Ædificat* as a motto, for it was credited with scooping out a deep lake basin in one place and laying down a thick cushion of "till" in another. The most important additions to knowledge since the valuable summary in Dr. Heim's "Handbuch der Gletscherkunde" (1884) have been Prof. T. C. Chamberlin's observations, completed by his studies in Greenland, that in large glaciers an amount of material, greater than was generally supposed, is transported embedded in the ice (englacial), particularly in the lower part, in which, owing to shearing movements, it often assumes a rude stratification. Thus in certain circumstances, a very remarkable instance of which was described in 1898 by Profs. Garwood and Gregory, materials may even be carried uphill for a certain distance.

Students will find the twenty pages containing a summary of what has been written about drumlins or drums very useful for reference, though whether they will arrive at a clear conviction of how these were formed is less certain. That, however, is the fault of the subject, not of the author, for they are among the greatest puzzles in glacial geology. In America, in some districts of which they seem to be especially well developed, they form oval hills, occasionally as much as a mile in length, their breadth being about two-thirds of this, and they rise, according to their area, from 25 to 200 feet in height. They are composed of similar material to till, with slight or no signs of stratification, and when numerous show a rude parallelism. The principal facts in regard to their structure are generally admitted, but here unanimity ceases.

We owe a debt of gratitude to the author of this work. In such a subject, indeed in any one connected with glaciers, the task of searching through its literature is most laborious, and as the student often finds hypothetical inferences more abundant than careful descriptions of facts, he is tempted to doubt, as did the charity boy when he got to the end of the alphabet, "whether it was worth going through so much to get to so little." This book, with its summaries and useful indices, will enable him to ascertain what observations are on record and what hypotheses have been formulated. He will also find, in the account of the conference in 1899, the latest classifications proposed (in which, we think, over-minute distinctions are attempted), and will be enabled to begin personal investigations with a general knowledge of previous opinions, more than which is apt to be a hindrance rather than an advantage. T. G. B.

CHEMISTRY OF PAINTS.

The Chemistry of Pigments. By E. J. Parry and J. H. Coste. Pp. viii + 280. (London: Scott, Greenwood and Co., 1902.) Price 10*s*. 6*d*. net.

THIS book is divided into four parts or chapters. The first of these, occupying just seventeen pages, deals with the optical origin of colour; the second chapter, entitled the "Application of Pigments," discusses in separate sections their purely artistic uses, their decorative employment and their protective qualities. These sections are followed by descriptions of the methods of applying pigments, including pastel, water-colour, tempera, oil-painting, keramic painting, enamelling, glass and mosaic. Large use is made, in the first of these sections of chapter ii., of Russell and Abney's 1888 report on the "Action of Light on Water-Colours," and in the third section of Mr. Harry Smith's recent experiments on the protection against the rusting of iron afforded by many different kinds of paints. The two chapters which constitute the body of the work before us and occupy a couple of hundred pages are entitled respectively "Inorganic Pigments" and "Organic Pigments." Here we find much information of interest and importance in the actual analyses given of individual samples of different pigments and in the notes on methods of examining and testing pigments. But some pigments, such, for instance, as aureolin and cadmium yellow, are treated too summarily in view of their artistic importance, while to other pigments, notably to the large group of "coal-tar lakes," is assigned a treatment which they do not deserve.

And here the question forces itself upon a reviewer's attention, "For what class of readers has this book been written?" The authors speak in their preface of "those who are called upon to use or examine pigments

as a guide to the selection of those which are suitable." If students of art and painters are here meant, we fear that a large part of the information offered for their instruction will be thrown away, for none of them are likely to learn much from such statements as this (p. 258): "The basic colour auramine is imido-tetramethyl-diparadiamido-diphenylmethane." Perhaps, however, Messrs. Parry and Coste intended to address themselves to those who are to "examine pigments" rather than to those using them. If so, the work before us certainly presents, with the limitations of omission and inclusion previously indicated, a convenient compendium of figures and facts. A reasonable critic is averse to making much ado about misprints and mistakes that are akin to misprints, for he knows how provokingly these blots on his work elude the notice even of the really instructed author. But the pages before us seem to be in unusual need of correction. Take these examples: Fraunhofer (pp. 3 and 8) should not have an "e" before the "n," while the "o" ought to be without *umlaut*. It is surely a mistake to attribute to linseed oil a tendency to crack (p. 64). Viridian is the proper form, not vividian and veridian (p. 114). Hydrolised (p. 115) is incorrect. For arsenate (p. 157, line 31) read arsenite. The formula for gambogic acid, $C_{30}H_{35}O_6$ (p. 271), and that for euxanthic acid, $C_{19}H_{18}OH$ (p. 273), are alike impossible. The table of analyses of Indian yellow (p. 274) is incorrectly reproduced from Thorpe's Dictionary. On p. 231 globorus occurs as a specific name.

Quotations from Church's "Chemistry of Paints and Painting" are numerous, but are handsomely acknowledged.

OUR BOOK SHELF.

Handbook of Sanitation. By George M. Price, M.D. Pp. xi + 317. New York: John Wiley and Sons; London: Chapman and Hall, Ltd., 1901) Price 6*s*. 6*d*. net.

THE circle of those whose duties compel them to make a special study of sanitary questions is a rapidly widening one in the United States of America, as indeed it is in this country; and one gathers from the author's preface that in spite of the growing number of sanitary inspectors, the still greater number of candidates for inspectorships and the general interest in sanitary questions, there are in America no text-books in which the necessary knowledge is set forth in a concise and suitable form. Of course the sanitary laws and sanitary practice are different in the United States of America, or otherwise we could supply the deficiency from the somewhat extensive literature which exists upon the subject in this country. The general principles of sanitation apply to all countries, but the extent and nature of their application are often determined by legislation of varying character and scope. It is for that reason that many of the English text-books on sanitation are of limited use in America, and that the present volume will only appeal to a few English students.

In part i. of the work a *résumé* is given of sanitary science. The matter is often far too condensed; the important subject of water and water supply is, for instance, dismissed in about seven pages, and in this part, and this part only, there are one or two matters to which exception may be taken:—"Cretinism, as well as goitre, has been traced directly to a certain chemical composition of the soil" (p. 7); the contents of sewers are the breeding-places for various virulent bacteria . . . and constitute a favourable culture-medium for all other disease-causing organisms"; and in Fig. 22 a "washdown" W.C. is described as a "washout" form.

It is curious for us in this country, where iron house-drains are so rare, to read that the house-drain "should be hung on the cellar-wall or ceiling, unless this is impracticable, as when fixtures in the cellar discharge into it."

Part ii. is on sanitary practice. In this part are given the methods of application of sanitary science in various municipal departments, with extracts from the law, rules and regulations of New York and other municipalities. This constitutes the best part of the book, although here again certain matters (food, disinfection, &c.) are far too sketchily dealt with.

Part iii. of the book relates to the inspector, his duties and qualifications; and part iv. contains, besides useful chapters on sanitary law and sanitary organisation in the United States, extracts from model laws on various branches of sanitation.

Advanced Exercises in Practical Physics. By Prof. Arthur Schuster and Dr. C. H. Lees. Pp. x + 368. (Cambridge: University Press, 1901.) Price 8*s*.

IN this book the authors describe some seventy exercises in practical physics suitable for students preparing for a B.Sc. degree. The exercises, therefore, deal with elementary subjects, which are described at considerable length; for the authors attach "greater importance to neat and accurate work, properly recorded, than to the number of experiments which a student performs." The title "Advanced" is here used to mean that the work is to be done in a manner befitting an advanced student rather than that the subjects are illustrative of the higher parts of physics.

The contents of the work are divided into six books. The first book contains preliminary matters, amongst which appears the calibration of the spirit-level, which is generally omitted from text-books, although the instrument is one of frequent use. The second book is devoted to mechanics and general physics, and here we are glad to see twenty-four pages on the balance, for the experience of teachers is that students know, as a rule, very little about this important instrument. In the third book heat is the subject, and special stress is put on the proper study of the cooling corrections in calorimetric experiments. If the methods indicated here are carefully carried out, the student should obtain very satisfactory results in his heat measurements. The fourth book contains sound, and the fifth light. In the latter we have a very full discussion of the spectrometer. Polarisation is introduced in two exercises. The sixth book deals with magnetism and electricity.

It is refreshing to read this text-book, for it is not a mere compilation from others, and the teachers and students who use it will feel that they have a guide written by authors who have thoroughly and exhaustively considered the principles and methods of the experiments they are describing. One of the aims of a text-book must be to add to the convenience of the teacher and student in getting at the groundwork of a subject, and this is eminently done in the one before us. The clearness and logical order of the descriptions will greatly facilitate the student's work, and by its use, supplemented with experimental lectures, we think a wide knowledge of physics from the point of view of the facts will be obtained. The diagrams and illustrations are new and exceptionally well done, and the type and get-up of the book are excellent.

The work can be strongly recommended to teachers in schools as a reference book on practical physics, and to university students for general use in the laboratory.

S. S.

Recherches Expérimentales sur les Spectres d'Étincelles. By G. A. Hemsalech. In three parts. Pp. xvi + 135. (Paris: Libraire Scientifique, A. Hermann, 1901.)

THE author, as an introduction, gives a short historical notice of the investigations on the nature of spark spectra by Wollaston in 1802, Talbot and Wheatstone in 1836, and later those of Masson, Ångström, Kirchhoff, Miller, Huggins, Lockyer, Hartley and Adeney, Eder and Valenta, Exner and Haschek.

The first part of the book is then devoted to a short description of the characteristics of various types of spark, ordinary, intermittent and oscillatory, with the influence of varying self-induction on those of the latter description.

The second part describes in detail the apparatus, electrical and spectroscopic, used in the investigations, with illustrations of typical sparks of the three mentioned classes.

Part iii. is occupied by a series of tables showing the wave-lengths of the lines measured in the spectra of the fourteen metals, Fe, Mn, Ni, Co, Cd, Zn, Mg, Al, Sn, Pb, Bi, Sb, Cu, Ag, with their relative intensities under three degrees of self-induction. The lines in the spectrum of air are also tabulated, showing their varying intensity in the spectra produced by the above metals being used as poles.

The variation of the self-induction is accompanied by different results according to the metals used, and the fourteen elements investigated are divided into two groups, one containing Fe, Mn, Ni, Co, the other the remaining ten metals. With the first group, increase of self-induction produces a general increase of brightness of the constituent spectral lines, while in the second group the intensities of the lines are diminished by increasing the self-induction. The lines due to air may be completely eliminated.

The work, commenced by Schuster and Hemsalech conjointly, has been continued by the present author in the physical laboratory of the Faculty of Sciences of Paris at the Sorbonne. C. P. B.

Moral Nerve and the Error of Literary Verdicts. By Furneaux Jordan, F.R.C.S. Pp. xxiii + 141. (London: Kegan Paul, Trench, Trübner and Co., Ltd., 1901.) Price 3*s.* 6*d.* net.

THE aim of this little book is to throw some light on the effects in life and literature of two different points of view, the literary and the scientific. The first chapter lays down some "guiding truths" on mind and matter; mind is regarded as the function or action of nerve matter, just as contractility is the action of living muscle. All the manifestations of life—morals, religion, laws—are based on quantities, states and changes of nerve-matter. "Matter" is used as meaning natural stuff of which we have some knowledge. The second chapter expounds some "guiding truths" on moral nerve. Morality need not be defined; we know what it is. In men and animals the moral sense is predominant; in both, the impulse to do right is stronger than the capacity to think clearly; few men can measure the planets, but every man strives to preserve from danger the lives of his fellows. How came men and animals to be first of all moral? Because they possess moral nerve-matter; morality is nothing more than the action of moral grey-matter, and the moral apparatus came into existence because it is a factor essential to life. A material moral apparatus exists somewhere and somehow within the skull, and there are grounds for believing that moral nerve is more or less separate nerve, freely communicating with all other varieties of nerve, but characterised by greater simplicity and directness. The next two chapters are devoted to Mr. Spencer and Huxley as moralists. Mr. Spencer underestimates the potency of nerve-organisation, and is wrong in putting the origin of the moral sense quite late in the course of evolutional time, the truth being that a certain bed-rock code is found wherever life is found. In common with literary thinkers, he fails to see that creeds, philosophies and moral codes are not the producers, but the products of living human nerve. Huxley is judged by his Romanes address on "Evolution and Ethics," and the verdict is that the address is marked by not a little confusion, inconsistency and inaccuracy. The fifth chapter, on the principle of punishment, which concludes the first part of the book, introduces us to a fresh theory of the origin of morality; it now appears that the punishment of immorality is the one method by which morality originated. The chapter concludes with some interesting remarks on destructive anarchism and its remedies, but is marred by the grotesque suggestion that in order to effect a maximum of humiliation the assassin should, by way of punishment, be flogged by a woman!

Part ii., which occupies about half the book, deals mainly with the errors of literary verdicts, and if Mr. Spencer and Huxley fall short of the scientific ideal, we are not surprised that the student of nerve should find much to criticise in Tennyson, Mill, Carlyle, Emerson and Goldwin Smith. It is unnecessary to give an account of this part of the work; the author's point of view will be understood from our summary, given mainly in his own words, of part i. He has evidently read much, writes brightly, and has a fine enthusiasm for truth, but a fundamental error runs through the whole of his book; he assumes the existence of moral nerve, timid nerve, reasoning nerve, &c., and writes about them and reasons from them as if they were well-established realities like motor or sensory nerve, whereas, as a matter of fact, nothing is known about them. We should welcome any real contribution to our knowledge of the relations between the psychical and the physical aspects of thought, but the author gives us nothing of the kind, and in his crude doctrine of moral nerve, moral grey-matter and so forth he is merely playing with words.

Domestic Economy for Scholarship and Certificate Students. By Ethel R. Lush. Pp. vi + 251. (London: Macmillan and Co., Ltd., 1901.) Price 2*s.* 6*d.*

THE aim of the author of this small volume has been to provide for teachers a concise and clearly-written statement of domestic economy which shall cover the syllabus of the King's scholarship examination and the certificate examination of the Board of Education.

Domestic economy is a subject of wide range, comprising, not only the skilful management of domestic affairs and the wise expenditure of the income, but, in addition, the laws of health and the physiological principles underlying them, the management of the sick, and the intelligent treatment of ailments and accidents on general principles. The author is certainly to be congratulated on having attained her object in a most satisfactory manner. The matter is very clearly expressed, and great judgment and care have been exercised in the presentation of a difficult and complicated subject in order to maintain a suitable proportion in the treatment of the various branch-subjects comprised within the somewhat extensive scope of study of domestic hygiene.

The subject-matter is remarkably well dealt with in the short space at the author's disposal, and having regard to its variety, the teaching is exceptionally sound and correct. In a subsequent edition, however, the following facts should be taken into account:—

The illustrations of the starch grains on p. 7 are so poor as to be practically useless; the specific gravity of average cow's milk is not 1028 (p. 29); the determination of the melting point is of little value as a means of testing for margarine in butter samples (p. 37); and the most characteristic symptoms of enteric fever, consumption and small-pox are omitted, while those of other communicable diseases are given.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

Huxley's Review of the "Vestiges of Creation."

IN the "Life and Letters" of Charles Darwin (vol. ii. p. 189), Mr. Huxley wrote:—"The only review I ever had qualms of conscience about, on the ground of needless savagery, is one I wrote on the *Vestiges*."

Can any of your readers inform me where Huxley's review of the "Vestiges of Creation" was published? I imagine it to have been written about 1853–54. FRANCIS DARWIN.

Botanical Laboratory, Cambridge, February 13.

Birds attacking Butterflies and Moths.

PROF. POULTON has asked me to recall any observations of my own of the attacks of birds upon butterflies. Unless one makes a note at the time of occurrence it is seldom one can recall to mind any particular instance of the kind, although it is not so rare as it appears; but of the two following instances I have still a vivid recollection. The first occurred during the beginning of August 1892, near Wokingham, Berks.: I was chasing a Clouded Yellow (*Colias edusa*, Fabr.), the first seen of the autumn brood, so that I was all the more eager to capture it, when much to my chagrin a Spotted Flycatcher (*Muscicapa grisola*) darted from a fence and caught it. The other observation was made during the summer of 1897 and deals with one of our common moths, which I am aware are more frequently attacked than butterflies. Whilst proceeding along the Cowley Road, Oxford, I saw a House Sparrow (*Passer domesticus*), making frantic efforts to capture a noctuid moth which seemed to be a Turnip Moth (*Agrotis segetum*, Schiff.). The peculiar way in which the moth seemed to roll over and over in the dusty road and the eagerness of the sparrow, together with the loud chirping which it kept up all the time, caused quite a small knot of spectators to assemble to watch the apparently unequal contest, and when at last the moth baffled its pursuer and flew away there was an audible murmur of applause.

22 Southfield Road, Oxford. A. H. HAMM.

HAVING seen some correspondence in the last two numbers of NATURE on birds attacking butterflies, I think the following may be of interest.

Early in June, 1900, when fishing at Belleek, co. Fermanagh, I noted on several evenings very heavy "hatches" of one of the larger sedge flies (*Phryganea sp.*), locally known as the wall-fly. On these evenings large numbers of gulls would come in from the coast, four miles distant, and steadily hawk up and down the river and neighbouring meadows, taking the fly eagerly. Subsequently, when the May fly was "up" on Lough Erne, it was common throughout the day to see flocks of gulls similarly employed, and this habit was so well known to many of the local gillies that it was no uncommon thing to fish first that part of the loch where the birds were busiest. A friend of mine—a good field naturalist—informs me that he has frequently seen sparrows, and on one occasion a greenfinch, catching butterflies which, so far as he remembers, were cabbage whites.

C. G. SELIGMANN.

St. Thomas's Hospital, February 14.

AS this subject is again interesting your readers, I would repeat that both my gardener and myself have independently observed robins capture and swallow the large cabbage white butterfly. HOWARD FOX.

Rosehill, Falmouth, February 18.

King Og's Bed.

I SEE that Mr. Wells, in his interesting discourse on "The Discovery of the Future," mentions "a sort of bed of King Og, to which all expressions must be lopped or stretched." We are told in Numbers that King Og had an iron bedstead, which was 9 cubits long and 4 cubits broad. But I cannot find that he put his bedstead to the use suggested by Mr. Wells. Is it possible that this gentlemen's memory is at fault, and that he is confusing King Og with the ancient Greek robber Procrustes, who was accustomed to torture his captives by stretching them if they were too short for his bed, and by lopping off portions of their legs if they were too long to fit the bed? T. B. S.

Edinburgh, February 10.

"T. B. S." is quite right. I regret very much that I did not verify my quotation. A confusion of Og's bed and the lopping propensities of Adoni-Bezek seems to have decayed to the likeness of Procrustes. I have lived in this error for years. I have often used the image of King Og's bed in conversation and, I think, in published matter. No one has ever detected my slip, and it is by no means impossible that I am the centre of propagation of a mistake that will turn up again. H. G. WELLS.

The Severn Bore.

DURING the past three years I have been observing the bore on the Severn, and have taken several measurements of the leading wave, or "head" as it is called here, as well as of the speed of the stream.

The river at Newnham being considerably wider than it is at Stonebench, where Dr. Vaughan Cornish made his observations, or at the Denny, where Mr. Whitmell was stationed, the phenomenon is not so remarkable—the speed is less and the height is lower.

Unluckily, since February 12, 1899, the heads for some reason or another have been comparatively low; none have since that date attained to 4 ft. 2 in., the height then measured. I was fortunate to obtain a photograph, which was published in the *Graphic* of February 18, 1899, but owing to the lack of light, for the best bores come up early in the morning, the plate was underexposed.

The popular idea of the height is greatly exaggerated; 6 ft. is stated to be not uncommon when a south-west wind is blowing, but during last September the maximum measured by me was 2·1 ft. and the speed 5·2 miles per hour (330 yards in 2 mins. 10 secs.).

Mr. Whitmell refers to the sound of the approaching bore being audible for some distance. It is a weird and grand sight during the moonlit September evenings to see the white line of foam advancing up the long stretch of river above Newnham, and the sound of the approaching mass of water is heard for more than a mile away, long before anything is to be seen.

Whatever may be the safety of a small boat on the upper reaches, it is not considered safe to be in a boat when the tide comes up here, and not many years ago two fishermen were upset with their boat and drowned below Awre.

The increase of speed above Newnham is always attributed to the narrowing of the stream and to the greater steepness of the banks, but neither here nor at the Denny have I ever seen anything approaching to seventeen miles per hour.

There is another phenomenon to be seen at Newnham which does not occur higher up, namely the formation of "racers," or series of waves caused by the flowing of the rapid current over the sandbanks. These "racers" occur in rhythmical order as the channel fills up, and at some few minutes after the head has passed, lasting only for a short time at any one spot, ceasing as soon as the water has reached a certain depth; they are violent in their action, and leave a record behind them in the shape of an alteration in the configuration of the sandbank over which they have surged and boiled whilst the water in midchannel rapidly but smoothly rises in level. E. W. PREVOST.

Newnham, February 15.

Squilla desmaresti.

SHORTLY after the publication of my note in the *Journal* of the Marine Biological Association, on the appearance of this stomatopod in the North Sea, I received a specimen from Mr. W. W. Dunlop, who informed me that it had been taken off Selsea Bill. Further inquiry resulted in my learning that it was taken "about the second week in April last year." Some three or four other specimens have lately been taken in the neighbourhood, where it was till now unknown.

It would be well to call attention to this fact soon, so that fishermen may try to find out if last year's appearance was extraordinary, or the result of better or luckier observation.

I may point out that an element in the case is the temperature of the water. F. JEFFREY BELL.

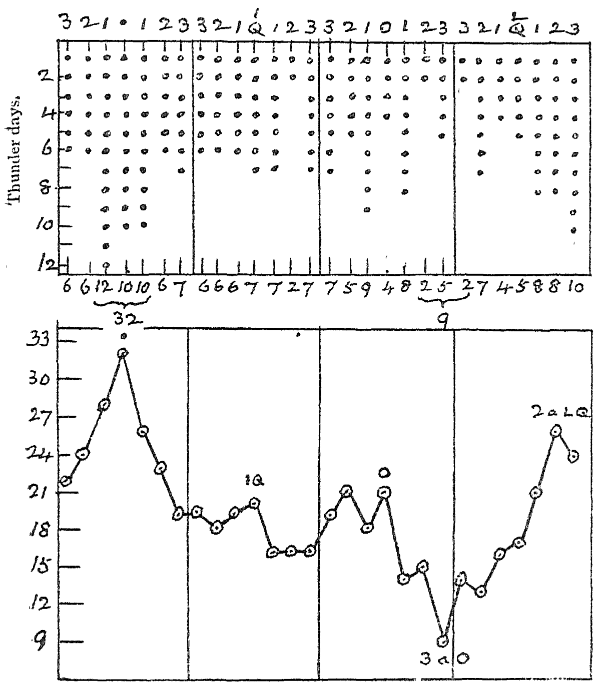
British Museum (Natural History)

The Moon and Thunderstorms.

IT is known that several meteorologists have affirmed a connection between thunderstorms and the lunar phases. In his recent admirable "Lehrbuch," Dr. Hann appears to favour this idea somewhat, and he gives some account of researches on the subject (p. 662).

I do not remember to have seen the Greenwich data treated from this point of view. It might, therefore, interest your readers to see how days on which thunder was heard at Greenwich in the last thirteen years (summer half) are distributed in the week about new moon, about first quarter, &c. This is shown in the diagram, where each dot represents one such day. The number of dots in each case is given below; and in the curve, each point represents the sum of three consecutive members of this series.

Lunar Quarters.



It will be seen that the extremes come about new moon (maximum) and about midway between full moon and last quarter (minimum). While the three-day group commencing with second after full moon had 9, that about new moon had 32—nearly four times as many.

This curve might be usefully compared with that, similarly obtained, for wet days (or days with 0·5 in. or more) at Greenwich, in twenty-four years (given in NATURE of August 29, 1901).

Arranging those 182 days by weeks and reckoning percentages, we have:—

	Week about New Moon.	1st Qr.	Full Moon.	4th Qr.
	57	41	40	44
Per cent. ...	31	23	22	24

The latter figures may be compared with those given in Hann's work for

	N. M.	1st Qr.	F. M.	4th Qr.
Kremsmünster (Wagner)	26·4	27·4	20·9	25·3
Aix la Chapelle (Polis) ...	26·9	27·5	21·5	24·1
Batavia (van d. Stok) ...	27·4	24·5	24 2	23·9

All agree in showing a larger percentage about new moon than about full moon, and in the two earlier phases than in the two later. The values for Kremsmünster and Aix are for much longer periods, and it is possible that a larger induction for Greenwich might bring out still closer agreement. The grouping by weeks, in the case of Greenwich, seems hardly to do justice to the contrast presented. It may be well, further, to remember that a 26-day period in thunderstorms, corresponding to the sun's rotation, has been affirmed.

Sidmouth, February 6. ALEX. B. MACDOWALL.

Progressive Variation in the Malayan Peacock-Pheasant.

IN looking over the specimens of this species (*Polyplectrum bicalcaratum*) in the Indian Museum, I have come across a most interesting skin of an adult male, showing variation in the direction of greater ornamentation. Normally, this peacock-pheasant has ocelli only on the wings and tail and the upper part of the back; but in the present specimen several of the black-speckled buff feathers of the back, immediately below the ocellated region, have clusters of the small spots richly glossed with green like the ocelli, the rest of the black speckling of the feather remaining normal. The green specks are always near the end of the feather, in the position occupied by the ocelli. Furthermore, this bird has the long under-tail-coverts decorated near the tip of the outer webs with a not very bright green-glossed ocellus, the inner webs merely showing black patches, such as are normal on both webs of these feathers in other specimens. Thus this individual presents on the upper surface a variation which might be advantageous in sexual selection, and beneath a similar enhancement of beauty which could hardly be of any use, since the Polyplectrons show off in an attitude which prevents any display of the under-tail-coverts. It is therefore interesting as showing how the beauty of a species might be enhanced both with and without the assistance of preferential mating on the part of the females.

F. FINN.

Indian Museum, Calcutta, January 30.

The Inheritance of Mental Characters.

FURTHER discussion of this subject (*cf.* p. 245) should perhaps be postponed until the appearance of Prof. Pearson's detailed paper. Possibly, however, it may be permissible to discuss briefly Prof. Pearson's reply to my criticism.

(1) As to the possibility of proving the "soul" factor to be a reality, I would say that it may be possible some day to estimate very exactly the value of the other two factors (heredity and environment), and it will be significant if there is then found to be a residuum not accounted for. This line of reasoning is not new; compare A. R. Wallace, "Darwinism," chap. xv.

(2) It seems to me very likely that the correlation between the mental characters of brothers would be less than between the physical, if only the factor of heredity were considered. It does not follow from this that the mental characters are less inherited, taking the race as a whole, but only that they are less evenly inherited, so that the true measure of inheritance could only be determined by studying a number of successive generations. I tried to set this forth in the paragraph which Prof. Pearson says he cannot understand.

(3) There are, however, other disturbing influences. Even at birth, we must believe that we have not the simple product of heredity, as has been well explained lately by Prof. Ewart (*Sci. Trans.* Roy. Dublin Soc., October 1901, p. 366). Again, the several faculties do not mature at the same age, so that statistics based on children "in public schools, high schools, secondary and primary schools of all classes" cannot be strictly comparable, nor does it seem possible, in the case of mental traits, to make definite allowance for age, as can be done with more or less accuracy in the case of physical characters.

T. D. A. COCKERELL.

East Las Vegas, New Mexico, U.S.A., February 1.

ICELAND.[1]

FEW parts of the earth's surface possess so strange a fascination, at once attractive and repellent, as that large island which, away to the north-west of Europe, stands between the Atlantic and the Arctic Ocean. Its language and literature, its connection with the northern mythology, the antiquity and continuity of its annals, and its quaint customs and traditions have given it a special place in the history of nations. The strange aspect of its surface and climate—the home of frost and fire, the scene of some of the most colossal volcanic eruptions which man has ever witnessed, the site of vast snow-fields and glaciers, a region shaken with earthquakes, devastated by

1 "Geological Map of Iceland." By Th. Thoroddsen. Surveyed in the years 1881–1898. Edited by the Carlsberg Fund. (Copenhagen, 1901.)

appalling floods, swept by Atlantic storms and sometimes chilled by Greenland icebergs—these and other impressive features have made Iceland a region of peculiar interest to students of nature. To the geologist, in particular, the country offers a wide field for observation. Its ice-fields remain as relics of the Ice Age, and are still large enough to illustrate many of the characteristics of that period in geological history. Its volcanoes display almost every type of volcanic action, and present a marvellously extended chronicle, stretching back from the present day through the Glacial period into older Tertiary time. The vicissitudes of its climate and the general absence of a protecting cover of vegetation afford singular opportunities for the study of the progress and rate of denudation, while its many hundreds of miles of coast-line furnish inexhaustible materials for investigating the action of the sea on the shores, and the causes which lead to the advance or retreat of the land.

That Iceland has been much less visited than such an interesting region might have been expected to be has probably arisen mainly from two causes. In the first place, it lies a good way off, across a stormy ocean on which the means of communication are neither so frequent nor so luxurious as modern requirements demand, and, in the next place, when the traveller reaches the island, he finds that to journey through it involves, not only a good deal of expense, but exposes him to privations which he is not always well able to endure. Many who have shrunk from the voyage in face of these difficulties have longed for what comes next in value after an actual personal visit to a country—a good map of it, on a sufficiently large scale and with enough of detail to allow its main characters to be intelligently grasped. Geologists will be glad to hear that this want has now been supplied. They are well aware that for some twenty years the indefatigable Icelandic geologist Dr. Th. Thoroddsen has been at work, summer after summer, mapping his native island and publishing from time to time short notices of his investigations. Only a few of these notices have appeared in English journals; more have been translated into German, but the fullest and best accounts of his work are those in Danish, and more especially the series of papers in the *Geografisk Tidskrift* published at Copenhagen from 1884 up to the present time. Maps of various portions of Iceland, which have accompanied some of these papers, have shown with what skill and energy their author was carrying on his self-imposed task, in the midst of all the known difficulties of Icelandic travel. The work on which he has been engaged was rather the duty of a Government than what can be expected to be undertaken by a private individual. But he has stuck to it with courage until his materials have grown ample enough to permit him to embody them in a general map of the whole of the island.

This map is now issued in two sheets, printed in colours and published at Copenhagen, with the help of the Carlsberg Fund. It is on the scale of 1-600,000, or about ten English miles to an inch, which is large enough to show much detail that has never yet been expressed on a single map and summarised in so clear and intelligible a manner. The title and explanations of signs and colours are given in English. The map presents a more striking picture of the geology and physical geography of the island than has ever been before available, and contains a vast fund of instructive information in regard to matters not only of local, but of theoretic interest.

One of the first features to catch the observer's eye, as he glances at the distribution of the colours, is the wide area occupied by the Tertiary basaltic plateau. This vast underlying platform, on which all the later volcanic manifestations have been displayed, still forms the surface of most of the western, northern and eastern districts. Its nearly horizontal sheets of dark brown rock have been cut into innumerable fjords and inlets on the coast, above which they rise in long lines of mural precipice. Among the basalts lie layers of terrestrial vegetation, the famous lignites or "Surtarbrandur," the positions of which, where known, are indicated on the map. The plateau is diversified by the uprise of numerous masses of liparite and granophyre, which are especially developed in the eastern part of the island. They may be compared with the granophyre intrusions which have disrupted our own Tertiary volcanic plateau in the west of Scotland. A further coincidence between the volcanic geology of the two regions is to be seen in the scattered patches of gabbro shown on the map, though this rock does not appear to play the important part in Iceland which it does among our Western Isles. For the first time some adequate conception can be formed from this map of the extent and distribution of the palagonitic tuffs, breccias and conglomerates, for which Iceland has so long been noted.

The post-Tertiary eruptions have broken out along a broad belt of ground which crosses the island from south-west to north-east. Dr. Thoroddsen separates the "doleritic lavas" as a pre-Glacial and Glacial series from the "post-Glacial basaltic lava" and the "post-Glacial liparitic lava." Of the area and distribution of the huge floods of basalt, which have transformed so many hundreds of square miles of the interior of Iceland into black waterless and verdureless deserts, we can now form a clear idea. The vast expanse of the Odádahraun, which has been the scene of the most colossal outpouring of molten material, can be seen in its true proportions. We can realise, too, the source and extent of the great eruption from Laki in the year 1783, which has been made so familiar by the imperfect and incorrect notices of it handed down in text-books.

By a series of simple signs Dr. Thoroddsen has succeeded in separately indicating the positions of the great lava-domes, comparable with those of Hawaii, such as the massive Trölladyngja and others on the plateau of Odádahraun; of the volcanoes of Vesuvian type, built up of lavas and tuffs round a central orifice, like Hekla; and of the crater-rows, like that of Laki. The map shows clearly the important place which this third type takes in the vulcanism of the country. A further separation is made of the "glacial volcanoes" from those which are "glacial and recent." The positions of solfataras, hot springs and mineral springs are marked, and space is found for lines showing the trend of raised beaches and the highest ascertained limit of submergence.

Nor are the superficial formations omitted; the various Drift deposits of the uplands are represented by one tint and those of the lowlands and valleys by another, while on the south coast, the wide stretches of sand and mud, discharged by the hundreds of streams that descend from the great snow-fields and glaciers of the Vatnajökull and the western Skaptafells district, are distinguished from the other recent accumulations. An interesting feature of the map will be found in the arrows that mark the direction of the ice-striæ on the rocks. These signs indicate that while the general movement of the ice-sheet has been outwards on all sides, each separate mass of high ground has exercised an influence in guiding the ice-drainage. This local effect is well brought out in the north-western peninsula, where the striæ descend into the fjords on either side of the main watershed. The Glámu Jökull, which still caps that portion of the basaltic plateau, is thus the lineal descendant of the ice-fields that once spread over the whole island.

In comparing the coast-line of different parts of the island as depicted on this map, the geologist cannot fail to be struck with the contrast between that of the southern district and that of the rest. From Reykjavik right round the western, northern and eastern sides of Iceland, where the ancient Tertiary basalt-plateau meets

the sea, the shores are deeply indented with innumerable fjords and little inlets, above which the rocks rise in long lines of terraced cliff. Along the southern coast, the margin of the land consists for the most part of low flats and bars of fine sand and mud, brought down by the many rivers and streamlets that escape from the edges of the great glaciers and snow-fields. A contest is constantly waged between the Atlantic breakers, on the one hand, and the sediment-bearing inland waters, on the other. Bars and spits are thus thrown up, behind which stretch long narrow lagoons. For a distance of some 250 English miles such is the general character of the coast-line. In spite of the fury of the Atlantic storms and the occasional breaking down of the detrital barriers opposed to them, the sea has been losing ground. Since the Ice Age so much sand and silt have been carried down that a wide stretch of lowland has been gained, and the sea has become so shallow that for long distances no ship of any size can approach the coast. Yet such is the unfortunate physical geography of Iceland that, at least in the meantime, this accession of land brings but little advantage to the inhabitants. The territory is so liable to rapid inundation, and to be swept over by sudden floods, that it is too dangerous to be reclaimed, and often cannot even be crossed without serious risk. In that portion of it which lies nearest to the Mýrdal glaciers, an additional source of peril is furnished by the eruptions of Katla, which, buried under the snow-fields, from time to time finds a vent, disrupts and melts the ice, and sends it in huge masses down the floods that sweep over the plain and carry their freight of ice even out to sea. Dr. Thoroddsen has given in his various publications graphic though only too brief accounts of these operations, and his new map enables us to follow their scope with greater clearness.

Now that the great labour of preparing this map has been successfully accomplished, every geologist and every visitor to Iceland will hope that Dr. Thoroddsen may be able to devote himself to the preparation of a full description of his native country. He has accumulated a large amount of material, only a small part of which has been published, and this merely in brief outline. He has, doubtless, many parts of the island to revisit and many difficult questions to elucidate before such a volume or series of volumes can be written. We can only wish him continued health and strength for his important task. It is surely not too much to hope that work of so national a character and of so much general scientific interest will meet with such hearty support and aid in Denmark that it may be vigorously prosecuted to an early and successful conclusion. ARCH. GEIKIE.

NATURE STUDY IN SCHOOLS.[1]

WE have received the first part of the *Nature-Study Journal*, published by the South-Eastern Agricultural College, Wye, Kent, with a preface by Sir William Hart-Dyke and an introduction by the editor, Mr. A. D. Hall, principal of the College. This new publication is the outcome of a discussion held at the College during a summer course for teachers in 1901, and the thirty-one teachers, mostly from schools in Kent and Surrey, whose names are appended to the part received constitute the first members of a Nature-Study Society by which this journal will be maintained. The object of the journal, as set forth in the preface and introduction, is mainly to facilitate the teaching of "nature-knowledge" in rural schools, by enabling the teachers to interchange ideas and schemes of instruction and to be in communication with the Wye College as a central organisation. The whole subject of nature-teaching in rural schools has been brought into prominence of late years, and there has been a distinct revival in this branch of education to which we have, from time to time, called attention in these columns. The initiatory work of the Countess of Warwick in emphasising by practical example the necessity for the establishment of schools of science in rural districts (see article by Lady Warwick and Prof. Meldola, NATURE, vol. lix. p. 7), followed by the work of the Agricultural Education Committee inspired by Sir William Hart-Dyke and Mr. Henry Hobhouse, has been largely instrumental in bringing about this much-needed reform, and the demand for sound instruction in this kind of science has naturally been on the increase since the issue of the "Specimen Courses of Object Lessons, &c." by the Board of Education (NATURE, vol. lxiii. p. 603). It is to be hoped and expected that this demand will go on increasing, and the establishment of the present journal is therefore opportune. The great danger to education in this country is complete apathy and neglect in the first place, and then reckless precipitation and unorganised excess in order to try to recover lost ground. Rural education is bound to go through the usual phases, and we may already begin to ask ourselves whether there is anything to be gained by the multiplication of organisations, conferences and congresses, all carrying on much the same work and frequently overlapping in functions.

The Nature-Study Society has, however, in favour of its creation the circumstance that it is composed of teachers who are engaged in giving actual instruction in this subject in schools, and the journal is to be largely devoted to the publication of specimen lessons. Two such lessons are in the part before us, one on "Leaves and their Veining" by Mr. H. Brooker, of the Ewhurst National School, and the other by Mr. A. E. Chandler, of Puttenham, on "Dodges of Nature." The first point that cannot fail to strike the reader of these two lessons is their extraordinary divergence in standard. The collecting and classification of leaves according to their veining is a lesson in pure observation. The "dodges" referred to in Mr. Chandler's lesson are the contrivances for cross-fertilisation in long and short-styled primroses and in Salvia, and the pupil is afterwards told to collect some flowers of Arum, to study the inflorescence, and then to work out for himself the mechanism of fertilisation by the aid of hints given in the following form:—"What can be the work of the little hairs that nearly close the opening of some of the hoods? Do you notice any insects? Did you ever think out the design of an eel-trap or a lobster-pot?" It is obvious that these two lessons must appeal to pupils of different ages and acquirements. The new Society and its journal should have a useful career if only by enabling teachers to compare schemes, as in the two lessons noticed. Such specimens bring out very clearly the necessity for graded and connected series of lessons leading from simple observation and description up to observation combined with inductive reasoning. The introduction of nature study into rural schools cannot but be productive of good, and although, as the editor points out, it is not primarily directed to keeping children on the land, it may have this effect indirectly by leading children "to see that a country life has its own interests and is not merely stupid routine; particularly we want the children who do stay in the country to have laid a foundation of thinking about rural pursuits which can be built upon later." The Society will welcome as new members all teachers who are conducting nature-study classes, the only obligation being that the member shall be expected to send a specimen lesson for publication. The Society is worthy of support, and we commend it to the notice of teachers who are already holding, or who desire to conduct, classes in this subject, which is one that by proper handling can be made really fascinating to children of every degree of intelligence.

[1] *The Nature-Study Journal.* Published by the South-Eastern Agricultural College, Wye. No. 1. Pp. 12. (*Kentish Express* Office, Ashford, Kent.) Price 3*d*.

A DOUBTFUL DEVELOPMENT OF LOCOMOTIVE ENGINEERING.

UNDER the heading of "A New Development of Economical Railway Haulage," the *Times* of February 13 tells us that "we are on the eve of a mechanical revolution such as has never been seen since the introduction of steam," and enters in a general way into a statement of results said to have been obtained from an old Great Northern locomotive fitted with a new type of valve-gear, the use of which is said to reduce the consumption of coal nearly 50 per cent. and increase the hauling capacity of the engine considerably, when compared with a sister engine fitted with the ordinary gear and doing similar work.

Locomotive engineers are becoming accustomed to the rapid advances of electrical science, and seldom doubt what the electrical engineer may claim to have achieved; but with the locomotive things are different; the machine is not new, neither is the valve-gear; the coal consumption has been thoroughly tested and the various gears examined from every point of view, there being no particular variation of opinion as to the most beneficial distribution of steam in the cylinders.

For this reason it is extremely startling to be told that a modified valve-gear will reduce the fuel bill nearly 50 per cent. with an increased load, the boiler pressure being only 140 lbs. per square inch, considerably below the average working pressure of to-day.

The locomotive experimented upon was built in 1882, and was, therefore, of the late Mr. P. Stirling's design, a type of locomotive famous for having a very small boiler in proportion to the cylinder dimensions, and, therefore, one requiring to be forced to keep up the steam, the forcing being done by a very keen draught induced by a small blast-pipe; such engines are famous for throwing fire from the chimney-tops. Yet, besides claiming this abnormal economy, we are told that the exhaust is so soft that the question of fire-throwing is entirely got over and that spark arrestors may be considered things of the past—surely a wonderful result.

The article referred to fills a whole column of the *Times*, but we may be allowed to doubt the results given, for although the name of Mr. H. A. Ivatt, the locomotive engineer of the Great Northern Railway, is quoted more than once, the statements do not appear over his name, and until they do, locomotive engineers may be excused if they continue to hold adverse opinions. The economical working of the locomotive is no new study; it is in the hands of able men who, no doubt, would be highly delighted if they could clearly demonstrate a saving of 5 per cent. even over previous practice.

N. J. L.

NOTES.

SIR WILLIAM ROBERTS-AUSTEN, K.C.B., F.R.S., will deliver the tenth "James Forrest" lecture, on "Metallurgy in Relation to Engineering," at the Institution of Civil Engineers on Wednesday, April 23, the date having been unavoidably altered from that originally proposed.

ARRANGEMENTS have now been made for Major Ronald Ross, Walter Myers lecturer in the Liverpool School of Tropical Medicine, to proceed for the third time to Freetown, Sierra Leone, on the work of the School. The expedition which he will rejoin is the fifth organised by the School, and went out early last year under Major Ross himself with Dr. Logan Taylor.

THE International Congress on the Methods of Testing Materials, held in 1900, decided to offer a prize of 3500 francs to the author who has made the most important contributions to the subjects for the advance of which the Congress was organised. The adjudication of the award of this prize has just been placed in the hands of the Comite des Arts Mécaniques of the Paris Société d'Encouragement.

ARCHÆOLOGISTS and other students of antiquities will be glad to learn that it is proposed to obtain for Magdalene College, Cambridge, a copy of the head of Mr. F. C. Penrose, F.R.S., honorary fellow of the College, from the portrait painted by Mr. Sargent, R.A., for the Royal Institute of British Architects. The portrait will be presented to the College in recognition of Mr. Penrose's valuable services both to science and art. Among the supporters of the proposal are Dr. J. W. L. Glaisher, F.R.S., Sir R. C. Jebb, Prof. Liveing, F.R.S., Sir J. Norman Lockyer, K.C.B., F.R.S., Mr. A. G. Peskett and Lord Thring, K.C.B. Subscriptions are invited and should be sent (crossed Barclay and Co., Cambridge) to Prof. A. Newton, F.R.S., Magdalene College, Cambridge.

THE president of the Royal Geographical Society has made a special appeal to the fellows of the Society on behalf of the relief ship which must start not later than July next to obtain news of the *Discovery* and render assistance if necessary. It appears from the circular issued by the president that only 150 of the 4000 fellows of the Society have yet contributed to the funds for the relief ship. The council has, however, made itself responsible for the ship, which is now lying in the Thames and will shortly require to be furnished with stores and equipped with officers and crew. A spirit of loyalty should induce fellows of the Royal Geographical Society to provide the funds which will relieve the council of anxiety and ensure that essential precautions are taken for the safety of the members of the National Antarctic Expedition.

THE annual meeting of the Society for the Protection of Birds will be held on Wednesday, February 26, at the Westminster Palace Hotel, Victoria Street, London, S.W. The chair will be taken at 3 p.m. by Sir George W. Kekewich, K.C.B., secretary to the Board of Education. A proposal to establish a Bird and Arbor Day throughout the British Isles will be considered.

ON Tuesday next, February 25, Mr. W. N. Shaw, F.R.S., will begin a course of two lectures at the Royal Institution on "The Temperature of the Atmosphere, its Changes and their Causes." The Friday evening discourse on February 28 will be delivered by Prof. H. A. Miers, F.R.S., his subject being "Gold Mining in Klondyke," and on March 7 Prof. H. Becquerel, Membre de l'Institut, Paris, will deliver a discourse (in French) on "Radioactive Bodies."

A DISASTROUS earthquake occurred in Transcaucasia on February 13. Shemakha, the principal town in the area affected, has been completely laid in ruins, more than 20,000 people having been rendered homeless and 2000 lives lost. The first shock was felt about midday on February 13, and in a few seconds the Orthodox church, the mosques, the public buildings and hundreds of houses had fallen. The shocks were felt over a very wide area, and continued to recur during several days. A writer in the *Evening Standard* points out that in such a region as that affected the shocks may continue for a long time. To the north rises the great chain of the Caucasus, a region of crystalline and sedimentary rocks bent into great folds, not less remarkable than those in the Alps. In such a locality earth-tremors are at any time possible. In the latter chain no trace can be found of an extinct volcano, but Elbruz, the highest summit in the Caucasus, and Kasbek, which easily overtops Mont Blanc, are both ruined volcanic cones. Many more, though on a much smaller scale, are scattered over the region south of the Caucasus. In fact, signs of volcanic action are abundant over a very large part of the great upland plateau south of the Caucasus—the region where Turkey, Russia and Persia meet.

Ararat itself, though its crater has vanished, is an extinct volcano, for its rocks, where they disappear beneath the summit snows, are merely scoria. Some others, however, still retain their craters in a more or less perfect condition. A renewal of earthquakes and of volcanic eruptions, therefore, is not surprising. All the south of the Caucasus has occasionally suffered in this way. The neighbourhood of Ararat was severely visited in 1840; there was a bad earthquake in Asia Minor fifteen years later, and shocks are not infrequent in various parts of the region between the Black and Caspian Seas, the Eastern Mediterranean and the valley of the Euphrates.

PROF. E. C. PICKERING has completed twenty-five years of service as director of the Harvard College Observatory; and we learn from *Science* that in recognition of this fact the staff of the Observatory has presented him with a silver cup.

MR. HARRY F. WITHERBY is about to leave England on a new ornithological expedition to Persia. It is Mr. Witherby's intention to penetrate the mountainous region north-west of Shiraz, after working the area between that town and Bushire.

THE seventieth annual meeting of the British Medical Association will be held at Manchester on July 29, 31 and August 1. The president is Dr. G. B. Ferguson and the president-elect Mr. W. Whitehead. An address in medicine will be delivered by Sir Thomas Barlow, Bart., K.C.V.O., and an address in obstetrics by Prof. W. J. Sinclair. The scientific business of the meeting will be conducted in seventeen sections, which, with their presidents, are as follows:—Medicine, Dr. J. Dreschfeld; surgery, Mr. J. Hardie; obstetrics and gynæcology, Dr. D. L. Roberts; public medicine, Dr. J. Niven; psychological medicine, Mr. G. W. Mould; physiology and anatomy, Prof. Wm. Stirling; pathology, Prof. Sheridan Delépine; ophthalmology, Dr. David Little; diseases of children, Dr. H. Ashby; laryngology, Dr. A. Hodgkinson; otológy, Dr. W. Milligan; navy, army and ambulance, Brigade-Surgeon-Lieutenant-Colonel G. S. Elliston; dermatology, Dr. H. A. G. Brooke; pharmacology, Dr. N. I. C. Tirard; ethics, Dr. S. Woodcock; industrial hygiene and diseases of occupation, Dr. A. Whitelegge; tropical diseases, Sir W. R. Kynsey, C.M.G.

A SPECIAL committee of the Franklin Institute, Philadelphia, has reported in favour of the adoption of the metric system of weights and measures in the United States. The National Government is urged to enact such laws as will ensure the adoption of the system in its various departments, as rapidly as may be consistent with the public service. A number of questions have been discussed by the committee, and definite answers agreed upon. Thus, the opinion is expressed that no valid objection has been effectively urged against the metric system except that the numerator cannot be divided by two. A similar objection could, of course, be applied to the decimal system of currency in use in the United States. For convenient small units of everyday measurement, the millimetre is held to be better than either 1/16 inch or 1/32 inch, the latter being rather a fine subdivision for ordinary rough measurements. If the National Government can be induced to adopt the system in all its departments, it is believed that the adoption of metric measures throughout the country would follow within a reasonable time.

AT the Imperial Institute on Monday, Dr. C. F. Harford-Battersby, principal of Livingstone College, gave a lecture on "The Obstacles to Development in West Africa." After referring to some of the minor impediments to West African development, a description was given of the discoveries which have recently been made with reference to the malaria question. It is now admitted by all malarial specialists that the mosquito is the means of communicating this, and some other diseases, to man. In this connection reference was made to Major Ross and also to Dr. Manson, under whose leadership the London School of Tropical Medicine has done such useful work, both in educating a large number of medical practitioners proceeding to different tropical climates and in various expeditions for investigating the subject of tropical disease. The Liverpool School of Tropical Medicine has also conducted a series of investigations into the subject of malaria on the west coast of Africa, and is now engaged in carrying through important sanitary operations besides education work in this country. Dr. Harford-Battersby referred to the instruction that is being given at Livingstone College to missionaries in questions of tropical hygiene and to the facilities afforded by the Travellers' Health Bureau, mainly by means of the quarterly journal *Climate*, to those who might desire information with regard to what precautions should be taken in entering a tropical climate. In conclusion, he hoped that the Governments of the different Colonies would take up in real earnest the sanitary measures necessary to carry into practical effect the important discoveries which have been made by scientific experts, and that the public generally would recognise the necessity of acting upon the recommendations which have been made as to protection from mosquitoes and would cooperate in carrying through adequate sanitary reforms.

WE have received the *Annales* of the Magnetic Observatory of Copenhagen for 1897-8, of which Dr. A. Paulsen is director. The observatory is to be congratulated as being one of the very few institutions that publish magnetic observations in detail. The present volume contains hourly values of declination and horizontal force, and in addition the hourly and daily means have been computed, and the absolute extreme values are stated for each day.

DURING the past week most parts of this country have experienced severe night frosts. In the neighbourhood of London the thermometer has fallen as low as 14° in the screen, and 7° on the ground. In the midlands the readings have been considerably lower, and the exposed thermometer fell below zero. The temperature during February has not been so low since 1856, with the exception of three days in February 1895. The day temperatures have been low in most parts of the kingdom. On Sunday, with a maximum shade temperature of 35°, the solar radiation thermometer rose to 80° at Greenwich.

THE Report of the Meteorological Council for the year ending March 31, 1901, has just been presented to Parliament. The Council has been reconstituted and now consists of five of the original members, who act as directors; these receive remuneration for their services. Five additional members have also been appointed by the Royal Society, among whom we are glad to see the name of Dr. R. H. Scott, who has been so intimately connected with the Office since its transference from the Board of Trade in 1867. Mr. Francis Galton, whose work was especially noteworthy in connection with the improvement of meteorological instruments and methods, and who first suggested the term "anti-cyclone," now so commonly used, has retired from the management on account of age. The superintendence of the supply of meteorological instruments for the use of the National Antarctic Expedition was undertaken by the Council, and after consultation with Sir G. G. Stokes, the Campbell-Stokes sunshine recorder was remodelled, to register during the twenty-four hours. Among the more important operations of the Council may be mentioned the arrangements for the investigation of the London fog, in cooperation with the London County Council, the establishment of observations at 7h. a.m. in connection with the German and Dutch Meteorological Offices, for the improvement of the telegraphic weather service,

and the preparation of monthly pilot charts of the north Atlantic and Mediterranean, which have been frequently noticed in our columns. Arrangements have also been made, at the request of the United States Weather Bureau, for sending daily weather telegrams to Washington. The percentage of complete and partial success of the weather forecasts reached eighty-four, which is higher than that for any year during the last decade, except 1893, when the same high figure was attained. The success of storm-warning telegrams was 92 per cent.

A PAPER on wireless telegraphy is given by Prof. F. Braun, of Strassburg, in the *Physikalische Zeitschrift*, iii. No. 7. Without going into elaborate details as to the transmitter and receiver, it may be mentioned that the problem of resonance received careful attention in the construction of these apparatus, the desirable conditions being that waves of a certain frequency alone should be transmitted and received and that the receiver should be as sensitive as possible to these particular waves. The experiments were commenced by Prof. Braun at Strassburg in 1898; in 1899 they were continued at the mouth of the Elbe. Communication was set up between Cuxhaven and a lightship distant thirty-four kilometres. Later, messages were transmitted between Cuxhaven and Heligoland at a distance of sixty-five kilometres. It was thought possible that by means of an acoustical instead of a writing receiver, the distance from which messages could be received could be increased two and a half to three times.

IN connection with the campaign against hailstorms, Prof. V. Monti publishes in the *Bulletin* of the Italian Meteorological Office some statistics of the number of storms accompanied by snow at different stations, as recorded for the period 1881–1887 inclusive. The phenomenon of snow during thunderstorms is shown to be very rare in Italy, and in about one-fourth of the storms in which snow fell it was also accompanied by hail. When account is taken of the time of year as well as of the altitude of the station, it is found that in the majority of cases snowy thunderstorms occurred when snowy weather was the normal condition of affairs. There are but few records of snow falling out of season as a result of the sudden cold produced by thunderstorms. These statistics, so far as they go, are interesting as affecting the theory that by bombarding a thunderstorm the hail is transformed into snow. If snow frequently falls after a storm-cloud has been bombarded, and rarely under other circumstances, the theory in question obtains support. But, as Prof. Monti points out, we have not at present sufficiently complete statistics to enable any very definite conclusions to be drawn.

JUDGING from the capital figures which illustrate an article by "S" in *Globus* (Bd lxxxi. p. 58) on the perforated landscapes of Kappadocia, that country must present a most remarkable appearance. In the district of the ancient Cæsarea-Mazaca, a plateau composed of a bed of tuff is topped by a layer of lava; denudation has resulted in broad cañon-like valleys, from the flat floors of which arise innumerable pointed sugarloaf shaped pinnacles. Many of these have been pierced and tunnelled for dwellings for ages past, and the caves are still being made. Some of the caves were used for religious purposes, and we have ruins of temples and of Byzantine churches carved out of the solid rock.

THE current number of *Man* contains several interesting papers. Prof. Flinders Petrie gives a plate illustrating two dozen hitherto unpublished prehistoric Egyptian figures of men and animals. The Rev. R. A. Gatty describes his finds of pigmy flints from Lincolnshire; perfectly similar flints have been found in various other localities in England, as well as in Belgium, in France, and in India. These problematical implements are of very delicate workmanship, but more information is required before any definite statements can be made as to their use or their users. Mr. Gatty believes that they were actually made at Scunthorpe in Lincolnshire from flint river pebbles.

DR. WALTER E. ROTH, the Northern Protector of Aboriginals, Queensland, has recently published his third *Bulletin* on North Queensland ethnography. The subject is "Food: its Search, Capture and Preparation," and there is no need to say more than that the facts are presented with that fulness of knowledge and concise detail that characterise all Dr. Roth's writings. As an example of this thoroughness it may be mentioned that Dr. Roth refers to some 240 plants which are used as food in some form or another, the scientific name of each plant being given. In addition to these, the natives know of twenty-two plants which they use to stupefy or poison fish. The plates illustrate the various kinds of baskets, nets, snares, &c. used by the North Queensland blacks. The only fault we have to find with this very valuable paper is its shape, but being a Government Report it is probably unavoidable that it is printed of Blue-book shape; this must be put down to the official mind and not to Dr. Roth. The *Bulletin* is marked C.A. 81—1901, Home Secretary's Department, Brisbane.

THE principal article in *Nature Notes* for February is one on the enemies of trout, by Mr. E. T. Daubeny.

IN the February number of the *Irish Naturalist*, Messrs. Mellard Reade and J. Wright describe the occurrence of marine boulder-clay in county Cork, with a list of the contained Foraminifera.

OWING to the roughness of the passage, which has to be made in an open boat, visitors to the little island of Bardsey, lying off the extremity of Caernarvon, are few and far between, and it is therefore a favourite resort for birds of many species. A list of the species met with during a visit to the island in May of last year is given by Mr. O. V. Aplin in this month's *Zoologist*.

THE history of the gradual diminution of the habitat in Britain of the swallow-tailed butterfly appears in the February number of the *Entomologist's Monthly Magazine*. At the present day this fine species is met with only in Wicken Fen and Ranworth and certain other Broads in Norfolk. Formerly, however, according to the author, Mr. C. W. Dale, it occurred in no less than fifteen other English and Welsh counties.

TO the February issue of the *Entomologist*, Mr. W. J. Lucas contributes an account of the dragon-flies taken in Britain during the past year. Very interesting is the occurrence in Hampshire of the form known as *Oxygastra curtisi*, which has not been observed in Britain since 1882, when four specimens were taken at the same place. The author hazards some suggestions as to the breeding place of this rare insect in Hampshire.

IN a recent issue of the *British Bee Journal*, Mr. F. W. L. Sladen raises the question whether bees can hear. The author claims to have discovered that the so-called Nassanoff's organ—the membrane between the fifth and sixth dorsal segments of the workers—is really a scent-producing organ, and that this scent forms a means of communication between bees. He further suggests that bees have cognisance only of the well-known "hum," and do not recognise ordinary sounds.

THE second number of *The Emu* fully bears out the promise of its predecessor, and is illustrated by some excellent reproductions of photographs of Australian birds' nests. Perhaps the most generally interesting and important article is one by Mr. D. le Souëf, on protective coloration in Australian birds and

their nests, which is to be continued later. In a second, Mr. J. C. M'Lean accounts for the appearance of the swamp-hen, or bald coot, in localities in New Zealand where it was previously unknown, by the clearance and drainage of many of its former haunts.

IN the Report for 1901 on the Lancashire Sea-Fisheries Laboratory at Liverpool and the Sea-Fish Hatchery at Piel, Prof. W. A. Herdman directs attention to the urgent need on the Lancashire coast of a special steam vessel for the purpose of scientific and statistical work. The Fisheries Branch of the Irish Agricultural Department has now such a steamer working under the direction of a scientific adviser; and if similar investigations could be undertaken on the opposite side of the channel, and the two vessels worked on a common programme, Prof. Herdman is of opinion that "this most definitely circumscribed area of the British seas would be adequately investigated." It is earnestly to be hoped that the necessary funds may be obtained without difficulty. The general work of the laboratory has been carried on with success. At the Piel hatchery attention was confined during the year to the flounder, but in the current year more attention is to be devoted to the incubation of the eggs of the plaice. Appended to the Report is an account of the morphology and life-history of the plaice, by Messrs. Cole and Johnstone, forming No. 8 of the *L.M.B.C. Memoirs*. This appears to be the most elaborate account of any single species that has hitherto been published, and reflects the greatest credit upon its authors, who have devoted two years to their task. The plaice, which is one of the most important of the British food-fishes, is a local and sedentary type on which the effects of excessive fishing would be almost sure to make them, selves felt, and it has been the subject of more than one Government investigation. The importance of a full knowledge of the structure and habits of this fish, such as the authors give us, can- therefore, be scarcely overestimated. Much is to be hoped from the experiments in hatching and rearing the eggs and fry of the species alluded to above, for, as Prof. Herdman well observes, hatching and rearing are the real objects of institutions like the one under his direction, "And scientific men who have charge of fish-hatcheries will not be content till they have succeeded in rearing into young fish, at a reasonable cost, a sufficiently large proportion of the fry which they can now hatch from the eggs by the million."

WE have recently noticed Mr. D. G. Elliot's "List of the Land- and Sea-Mammals of North America," published at Chicago (NATURE, January 9). Since then we have received a copy of another work on nearly the same subject, prepared by Messrs. Miller and Rehn and issued by the Boston Society of Natural History. It is entitled "Systematic Results of the Study of North American Land-Mammals to the Close of the Year 1900," and embraces a larger area than Mr. Elliot's list, as it includes in North America the whole of the continent down to the isthmus of Panama and the West India Islands. It also serves to show, even more plainly than Mr. Elliot's list, the enormous additions lately made by the active zoologists of the United States to our knowledge of the North American mammal-fauna. Whereas Mr. True in 1885 only included about 400 species in his summary of this mammal-fauna, the authors of the present work enumerate no less than 1450 species and subspecies. Whatever may be the opinion of other naturalists about the status of some of these species and subspecies, all will allow that Messrs. Miller and Rehn have furnished us with a very useful summary of the results of the study of the North American mammals during the past fifteen years.

A WORK on "Meteorologische Optik," by Prof. J. M. Pernter, is in course of publication by Herr W. Braumüller, of Vienna and Leipzig, and the first part has been received. Prof. Pernter has given so much attention to the physical side of meteorology, and the analysis of optical phenomena, that his complete work ought to be of great interest. The part of the subject already treated is too general to admit of review, and we propose to defer our notice of the work until the whole of the parts have been published.

A SECOND edition of Prof. J. M. Coulter's inspiring little text-book entitled "Plant Relations: a First Book of Botany," has been published by Messrs. Hirschfeld Brothers. The chapters dealing with plant societies have been revised both in text and illustration, but otherwise few alterations have been made. As remarked in the review of the first edition (March 8, 1900, vol. lxi. p. 442), the book is an interesting and refreshing little manual, which ought to receive the attention of the teacher as well as the pupil. It should be of real service as a guide to nature-study.

WITH the laudable object of bringing science and scientific principles into every-day life and thought, a society has been formed and has issued a journal under the title of *Life*. The organisation at present has no name and its only designation is "our Society." A useful department of the journal is that in which advice is given as to the choice of books on various branches of science. There is an article on medical training and ideals, one on science and art in literature, and a third on the inaccuracies of the Old Testament—a subject which is perhaps better left alone by a society which hopes for success. The journal is edited by the secretary, Mr. R. A. Buddicom, 17 Craven Hill Gardens, Hyde Park, London, W., to whom all communications should be addressed.

THE *Transactions* of the Epidemiological Society (new series, vol. xx. 1900–1901) show that the Society is doing much to encourage the scientific study of disease. Dr. P. Manson, in a paper on some problems of tropical epidemiology, describes the work which has been done to establish the connection between mosquitoes and malaria, and suggests directions of further development. Why is it that Samoa, to take an instance, is free from malaria, while Mauritius has the disease present? The answer is probably that there is some organism in Samoa which is fatal to the malaria-bearing mosquito—Anopheles—while in Mauritius the insect can flourish; but the reasons for such differences are not clearly understood, and a systematic inquiry must be made before the conditions inimical to Anopheles can be exactly known. Similar remarks apply to diseases other than malaria; and Dr. Manson points out that expeditions to discover the causes and remedies of such diseases are even more necessary than expeditions to determine points of geological or geographical interest. Another paper in the volume is on plague in the nineteenth century, by Dr. A. K. Chalmers, who gives particulars of the outbreak of plague in Glasgow. Rats were plentiful in the affected houses, but they appeared to have escaped infection. Nearly three hundred rats were examined, but nothing suggesting plague was found. These results were in marked contrast with those described by Dr. Tidswell, of Sydney, at the close of Dr. Chalmers' paper. The facts obtained at Sydney showed conclusively that the plague was transmitted by fleas from infected rats. Among other papers we notice one on the diagnosis of plague, by Dr. E. Klein, F.R.S., which has already appeared in NATURE (vol. lxiv. p. 91); soil and typhoid fever, by Dr. J. T. R. Davison; and principles determining the geographical distribution of disease, by Dr. L. W. Sambon. A portrait of the late Prof. Max von Pettenkofer, of Munich, forms the frontispiece of the volume, and an obituary notice of this eminent investigator appears among the contents.

THE question of the nature of red phosphorus is one that has been frequently discussed, the general trend of the evidence being to show that red phosphorus is a polymer of white phosphorus. Some new and interesting experiments on this subject are contributed by Dr. R. Schenck to the current number of the *Berichte*. Starting with the well-known equation of van 't Hoff $-dC/dt = k.C^n$, in which C is the concentration, t the time, and n the number of molecules taking part in a reaction, he determines the velocity of transformation of white into red phosphorus in solution in phosphorus tribromide at 172° C. and 184° C., and finds that $n = 2$ is the only value of n which gives a constant value for k in the velocity equation. From this the conclusion is drawn that the equation $(P_4)_2 = P_8$ represents the first stage of the conversion of white into red phosphorus. It is, however, quite possible that this only represents the first stage in the process, the differences in the properties of the two varieties being so great that it is unlikely that they could be caused by such a small change in molecular weight.

AN important discovery in medical science is announced by M. Armand Gautier in the current number of the *Comptes rendus*. He has found that sodium methylarsenate, injected into the blood in minute amounts, is an absolute cure for malarial fever. Particulars are given of the treatment of nine cases, all of which had been contracted in Africa, and which were of such a severe type as to be refractory to large doses of quinine. The nine cases were rapidly cured, two only showing a slight relapse, and these yielded at once to a second injection. The progress of the cure was followed in each case by the examination of the blood, and the treatment was always followed by the disappearance of the specific hematozoa. The salt was also found to suppress entirely the anæmia associated with malaria. M. Gautier regards the results as sufficiently definite to authorise the substitution of this drug for quinine in pernicious malaria, although it still remains for further researches to determine the best dose, and whether administration by the mouth or hypodermically is to be preferred.

A COMPLETE index of the first thirty volumes of the *Journal de Physique* (1872–1901), arranged both according to authors and according to subject-matter of papers, has been announced.

THE behaviour of liquid sulphur dioxide as a solvent has been very completely investigated by Messrs. Walden and Centnerszwer, an account of whose researches is contained in vol. xxxix. of the *Zeitschrift für physikalische Chemie* (pp. 513–596). It is found that liquid sulphur dioxide easily dissolves a large number of (binary) inorganic salts and most salts of organic bases. The solutions of these salts are good conductors of electricity. The simple laws which regulate the conductivity of aqueous solutions of salts are in general not valid for the sulphur dioxide solutions. Amongst these may be mentioned Kohlrausch's law of the independent wandering of the ions, Ostwald's dilution law, the law according to which the molecular conductivity approaches to a maximum with increasing dilution, and the rule according to which the increase in the conductivity with the dilution is the same for all binary salts. The conductivity of solutions has been investigated at temperatures ranging from the freezing point of liquid sulphur dioxide to its critical point. The molecular conductivity increases at first with the temperature, reaches a maximum at a temperature dependent upon the nature of the dissolved salt, and then decreases with a further rise of temperature, becoming finally zero at the critical temperature, although the salts remain dissolved even at temperatures above the critical temperature. The authors conclude from this observation that electrolytic dissociation in solutions is an essential property of, or conditioned by, the liquid state of aggregation. Determinations of the molecular weight of dissolved salts by the boiling-point method give values higher than the normal, from which it would appear that the molecules of the dissolved salts are to a considerable extent polymerised, or form complex associated molecules containing molecules of the solvent.

THE additions to the Zoological Society's Gardens during the past week include a Macaque Monkey (*Macacus cynomolgus*) from India, presented by Dr. Worley; a Pochard (*Fuligula ferina*), European, presented by Dr. H. S. Jameson; a Smooth-headed Capuchin (*Cebus monachus*) from South America, a White-fronted Capuchin (*Cebus albifrons*), a Hoary Fox (*Canis vetulus*) from Brazil, a Blue-fronted Amazon (*Chrysotis aestiva*), five Giant Toads (*Bufo marinus*) from South America, an American Green Frog (*Rana halecina*) from Central America, two Gangetic Trionyx (*Trionyx gangeticus*) from India, deposited.

OUR ASTRONOMICAL COLUMN.

THE NEW BRUCE SPECTROGRAPH FOR THE YERKES REFRACTOR.—This instrument has been provided from funds supplied in 1899 by Miss Catherine Bruce and the Rumford fund of the American Academy of Arts and Sciences. The arrangement of the various parts has been designed in view of obtaining the greatest possible rigidity and uniformity of temperature, as the principal work for which it is to be employed is the determination of velocities in the line of sight. To this end several departures have been made from ordinary designs. The foundation consists of two castings rigidly connected by a framework of steel tubes, one of these castings, weighing about 200 pounds, being attached to the massive terminal ring of the 40-inch refractor by eight bolts. The collimator tube is firmly attached to this and the second casting, which latter also holds the framework on which the prism train is mounted. It was decided to use three prisms of such angle that the total deviation was 180°, thereby rendering the instrument more compact and free from flexure. The optical train, consisting of the correcting lens, collimating lens, prisms and camera lens, were made by Brashear from formulæ supplied by Prof. Hastings. The correcting lens is 57 mm. aperture, and is so designed that when placed 100 cm. in front of the focus of the 40-inch for λ 4500, the angular aperture of the large lens is not altered. The performance of this lens has been found to be very satisfactory, rendering it possible to obtain a star spectrum of uniform width from λ 4300–λ 4700.

The collimator has a triple cemented lens of 51 mm. aperture and 958 mm. focus.

The first set of prisms, made from Mantois glass, was not satisfactory, and has been replaced by prisms made from glass supplied by Messrs. Schott and Co., of Jena. These are not perfect, but have given sufficiently good results to warrant their adoption. The refracting angles are about 63½°.

Two camera lenses are provided, one being a Zeiss anastigmat, aperture 71 mm., focal length 449 mm., the other a triple cemented lens designed by Prof. Hastings, with aperture of 76 mm. and focus 607 mm.

For the region of H_γ the dispersion of this spectrograph is almost identical with that given by the Mills and Potsdam III. spectrographs.

For temperature control the whole instrument is enclosed in a double-walled case of aluminium; thick felt is packed in the space between the two metal sheets, and a helix of thin wire distributed through this provides a convenient means of keeping the temperature of the prism chamber almost constant for a considerable time. For comparison spectra, electrodes of titanium and iron are used, and also a vacuum tube of helium.

In following, the method devised by Huggins of using the slit plate as a reflector has been adopted, several variations being made to avoid the inconvenience of having the two slit-jaws in different planes with respect to the collimator axis.

An extensive series of preliminary photographs has been taken and reduced, and the instrument is now in use for standard determinations of spectroscopic binaries, &c., which can only be detected by the variable radial velocity deduced from the displacement of spectrum lines (*Astrophysical Journal*, vol. xv. pp. 1–27).

THE STRATIFICATIONS OF HYDROGEN.[1]

THE following pages give the outcome of attempts to prepare pure hydrogen, and experiments on the stratifications exhibited by the purified gas under the influence of an induction current. The researches were commenced in 1884 and have been continued intermittently to the present time.

Strips of palladium foil were charged with hydrogen by the electrolysis of dilute sulphuric acid, a 4-cell Grove's battery being used for one hour. After drying, the palladium strips were put in a glass tube and sealed between the hydrogen generator and vacuum tube. At first, crude gas from the generator was used to wash out the apparatus, and after many fillings and exhaustions—the last to the highest possible point—the generator and tap were sealed off, leaving only the palladium and drying tubes attached to the apparatus. A portion of the palladium was now gently heated; the gauge sank 12 cm., when it was again well exhausted and a little more hydrogen liberated. This was repeated three times, when the tube was exhausted to the stratification-point—about 4 mm.

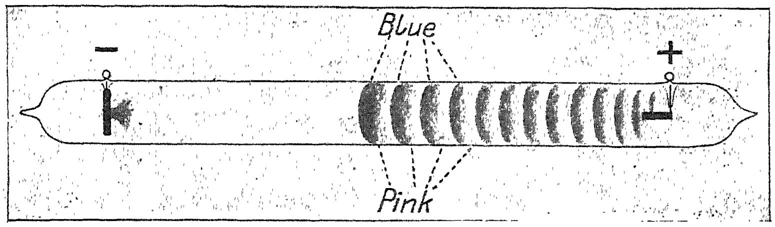


FIG. 1.

Parti-coloured Stratifications.

The strata were twelve in number and of a slightly concavo-convex button-shape, each of a blue colour on the convex side facing the negative pole, and pink on the other side. On eversing the current, the buttons faced round, always presenting

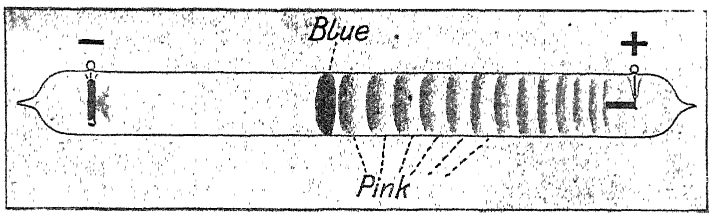


FIG. 2.

the blue face to the negative pole. Examination with a spectroscope showed strong hydrogen lines in the pink parts and both hydrogen and mercury in the blue parts. Fig. 1 shows the appearance at this stage.

The exhaustion was now raised to 2 mm., when the whole of the blue faces of the parti-coloured button suddenly migrated to one bright blue, well-formed button, nearest the negative pole, all the other buttons remaining pink. The appearance is shown in Fig. 2. Round the negative pole an indistinct halo showed both mercury and hydrogen; but on the blue button mercury only was detected, not a trace of even the brightest hydrogen line being there seen. On the pink portions the hydrogen lines were in excess, but mercury could be seen all along the tube.

A slight difference is produced in the purity of the colours of the strata according as aluminium or platinum poles are used. A pair of vacuum tubes was made, one having the usual shaped aluminium poles, the other having platinum poles of a special construction. Each terminal was of double wire, at one terminal bent into the form of a ring and at the other a straight pole. The ends of the wires forming the poles were sealed through the tube close together, but not touching, and terminated in loops outside, so that

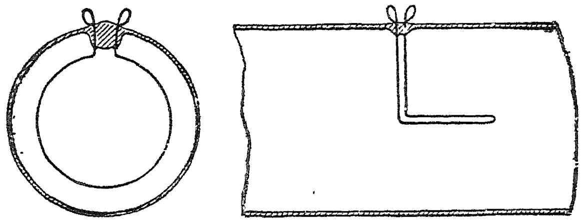


FIG. 3. (Full size.)

they could be raised to red or white heat by connecting them with a few battery cells. The arrangement will be readily understood by reference to the accompanying drawings (Fig. 3). Thus heat could easily be applied during exhaustion, first to one pole and then to the other, even while the induction spark was passing. At first much gas was liberated from the platinum, but by repeated heating, pumping, and passing the spark, all the occluded gas was abstracted, and then the fillings with hydrogen and subsequent operations were commenced.

The general plan of the apparatus is shown in the drawing (Fig. 4). At the end furthest from the pump is the hydrogen generator, A, consisting of a U-shaped tube filled with dilute sulphuric acid, having in one leg a plate of amalgamated zinc, B, and in the other a sheet of platinum, C. Both the platinum and the zinc are connected metallically to platinum wires sealed through the glass. A funnel with a stopper, D, sealed to the outer limb of the generator admits dilute acid when required. A tap, E, on the other limb enables the reservoir of hydrogen to be disconnected from the rest of the apparatus. Following this tap is a battery of three tubes, one, F, containing small lumps of dry caustic potash, the second, G, and the third, H, tubes containing phosphoric anhydride. Between the second phosphoric anhydride and the vacuum tube is another tube having sealed on to it, comb-like, seven projecting arms, J J, each containing a strip of palladium foil saturated with hydrogen.

The vacuum tube, K, is eight inches between the terminals and three-quarters of an inch diameter; it comes next to the comb, and then between it and the pump is a battery of tubes, each twelve inches long, to keep out the mercury. The first tube, L, is divided by a constriction in the middle, and contains, in the half next the vacuum tube, bright metallic copper, in the other half sulphur. The three next tubes, M, M, M, contain sulphur, but in the middle of each are placed a few grains of iodine separated from contact with the sulphur by a

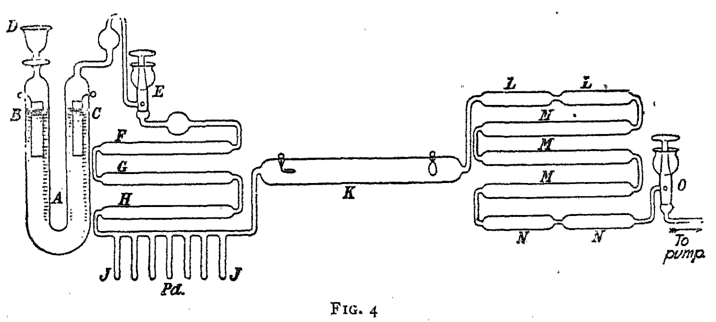


FIG. 4

plug of asbestos on each side. The sulphur is prepared by keeping it fused at a temperature a little below its boiling-point till bubbles cease to come off, so as to get rid of water and

[1] Paper read at the Royal Society on February 6 by Sir William Crookes, F.R.S.

hydrogen compounds. It is then allowed to cool, and is pounded and sifted so as to get it in the form of granules, averaging a mm. in diameter. Ignited asbestos is packed at each end of the tubes to keep the contents from blowing out when the vacuum is proceeding, or air is suddenly let in. Next follows a tube, N, N, constricted in the middle, containing in the first half phosphoric anhydride, and in the second finely powdered dry caustic potash. A tap, O, connects the apparatus with the pump to prevent diffusion of mercury when the pump is not in use. All parts of the apparatus were built up in place and sealed together with the blowpipe. The glass was new, and the apparatus had been kept apart from mercury until it was sealed together.

The apparatus was exhausted from air, the tap E being closed and D open. Electrolysis was then commenced (D being closed), and the tap E was slightly turned until the escape of hydrogen into the apparatus was equal to the speed of its generation. The apparatus was filled, and several times exhausted, until no improvement in the spectrum or stratifications could be seen. The electrolytic cell was then sealed off at a narrow constriction between the first potash tube, F, and the phosphoric anhydride tube, G. After good exhaustion, one of the branch tubes of palladium was heated, when the gauge sank several centimetres. Exhaustion and refilling from fresh palladium were repeated until no alteration was detected in the appearance of the strata. Then, for the first time, I obtained hydrogen strata showing no blue, either throughout the tube or concentrated in front, whilst the most careful examination showed no mercury. The stratifications were all pink, and showed the hydrogen lines strongly.

Many disadvantages were noticed in the apparatus just described, the chief being the danger of introducing more impurities than were kept out by the copper, sulphur and iodine tubes. The palladium method of introducing hydrogen was not altogether satisfactory, as only small quantities could be dealt with, and occasionally at a critical point the store was exhausted. Also, the electrolytic generator of hydrogen was too small. It was decided, therefore, to devise and fit up an entirely new piece of apparatus. In this another method was used for keeping out the mercury. It had been noticed that the diffusion of mercury from the pump proceeded the more slowly as the distance from the pump and the narrowness of the connecting tubes increased. It was thought that by introducing a long narrow spiral between the pump and the apparatus, one complicated system of tubes, with their attendant dangers, could be removed; the result showed this supposition to be correct. Two vacuum tubes were employed, one having aluminium, the other platinum terminals. The hydrogen generators were increased in size and number, and were so distributed that they could be sealed off one after the other during the progress of the experiment.

Stratifications in Pure Hydrogen.

The arrangement of the apparatus is shown in Fig. 5. The three hydrogen generators are called Nos. 1, 2 and 3. In No. 1 the gas is generated by the action of hydrochloric acid on zinc. This crude hydrogen is only used to drive out the air from the rest of the apparatus and to remove the air dissolved in the liquids. When it had done its work, the generator was sealed off between Nos. 1 and 2, at A. It was considered that having the apparatus to begin with full of even somewhat impure hydrogen was better than starting with it full of air. The second and third generators contain at the bottom a pasty amalgam of mercury and zinc forming one pole, and a piece of platinum forming the other pole; the electrolyte is dilute hydrochloric acid. Platinum wires sealed through the sides of No. 3 carry the current from three Grove's cells to the interior. After the apparatus has had generator No. 1 removed, a large quantity of hydrogen is passed through from the second generator, with the object of replacing the impure hydrogen by some of a purer quality. When No. 2 is exhausted, it also is sealed off at B, leaving only the third generator with its drying tubes connected with the apparatus. Before sealing off No. 2, filling and exhausting is carried on until the hydrogen shows no impurity when spectroscopically examined in a capillary tube attached to the vacuum tube. The gas from the first and second generators bubbles first through strong caustic soda, C, C, C, to remove any acid carried over from the generators, then through strong sulphuric acid, D, to take away the bulk of the moisture and thus save the drying tubes; it then passes through the purifying arrangements more especially connected with the third generator. Having sealed off Nos. 1 and 2, gas is evolved from No. 3 generator. Hence it passes through strong sulphuric acid in the tube H; then over a tube filled with granulated caustic soda F; and next through a tube, G, tightly packed with phosphoric anhydride. H and I are two taps, having a reservoir, K, between them. When full of gas, H and I are closed, and the tubes L and M, after having been exhausted to a high point, can then be fed with limited amounts of pure dry hydrogen by slightly opening tap I and closing it when equilibrium is restored between L, M and K. N is a spiral of narrow glass tubing immersed in a beaker of ice and water. At O is a tap to keep mercury from diffusing into the pump if the apparatus has to be left all night. The vacuum tube, L, is provided with aluminium poles and the tube M has the platinum poles made double for heating purposes, as shown in Fig. 3.

Hydrogen from the first generator was passed through the apparatus for two hours, when it was sealed off. The whole apparatus was exhausted to a high point and No. 2 generator was set to work. Hydrogen was passed several times at full pressure through the apparatus for one or two hours and then exhausted to the stratification point. During these operations the platinum terminals of one of the vacuum tubes were heated to full redness and the current was kept on both tubes for some hours to drive off occluded gases.

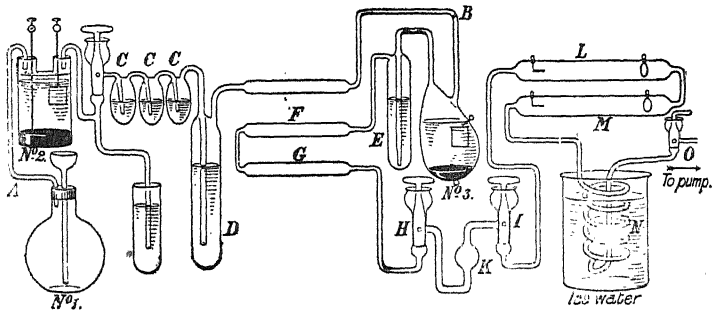


FIG. 5.

Finally, the second generator was sealed off and hydrogen used from the remaining generator. After much washing out with hydrogen at the ordinary pressure, exhaustion and re-filling were continued, and finally the reservoir K was filled, both taps, H and I, being closed. The tubes were highly exhausted to the non-conducting point, and tap I opened and then closed, so as to introduce a little hydrogen. H was then opened and again closed, so as to equalise the pressure in I, and exhaustion proceeded to the stratification point. At first the strata were irregularly coloured with a suspicion of blue on one face, but as the operations just described were continued, the blue faces disappeared, the stratifications assumed a pure pink hue and showed the hydrogen spectrum alone; no mercury was detected in any part of either tube.

From the first to the eighth filling the strata were pink with a trace of slaty blue colour on the faces next the negative pole. From the tenth filling the blue faces disappeared, and after the twentieth filling no trace of blue could be seen and the spectrum of hydrogen alone was visible.

On examining the spectra of the stratified gas in the two tubes, each showed strongly the line spectrum of hydrogen; but while the spectrum in the platinum-poled tube showed pure red, blue and green lines on a black ground, that in the aluminium-poled tube showed in addition the fainter hydrogen line spectrum in the yellow and orange. This result may be due to the greater surface exposed by the aluminium poles; it was not further examined.

Having at last succeeded in getting hydrogen free from mercury, experiments were instituted to verify the inference that

the blue components of the blue and pink strata usually attributed to hydrogen were really due to the presence of a trace of mercury.

Origin of the Blue Component of Parti-coloured Stratifications.

I used an apparatus similar to the last, but with only one generator. If my idea was correct, that the mercury in the course of a few hours diffused into the hydrogen tube from the pump when it was not at work, there ought to be an access of blue faces to the pink buttons after the exhausted apparatus had been at rest. After filling with hydrogen and exhausting several times, a hydrogen vacuum was obtained showing no blue faces to the pink strata. The apparatus was then left all night and the stratifications examined next morning. The blue colour to each face was now unmistakably visible. The refilling with hydrogen and exhausting was then continued. It was not possible in this way to get the tube entirely free from mercury, although it got less and less, as shown by the diminution of the blue faces.

Occasionally, when no mercury was present, a faint blue edging to some of the front pink strata was seen. This blue was too faint to show lines in its spectrum. After much searching, the blue tint was traced to the phosphoric drying tubes. A clean tube was taken for stratifications and sealed to the apparatus used in the last experiments. The whole was exhausted to a high point, and one of the phosphoric anhydride tubes was gently heated with a gas flame, the current kept going. Instantly a flood of blue light swept through the tube, and when concentrated in a narrow constriction the light showed a complicated spectrum which was not recognised: none of the characteristic lines of the phosphorus spectrum could be seen in it. The tube was cleared of the blue colour by introducing hydrogen and pumping it out a few times, and then hydrogen was introduced and exhaustion continued to the stratification point. The strata now were pink, with no appearance of blue. Warming the phosphoric anhydride tube at once reproduced the faint blue edging to the pink discs. This blue colour was different both in tint and intensity to the blue colour produced by mercury, but it was too faint to show a spectrum except in the constricted part.

It is of importance to ascertain whether the body producing this blue colour can be removed from the phosphoric anhydride. The drying tube was again heated to the subliming point of the anhydride, hydrogen passed in, and the pump worked until the vacuum was almost non-conducting. The heating, passing in hydrogen and pumping were several times repeated, the impurities diminishing each time. Ultimately a point was reached when, the tube being non-conducting, heating the phosphoric anhydride did not communicate any gas to the vacuum tube. At this stage the phosphoric anhydride still retained unimpaired its affinity for water. In any accurate experiment, therefore, the phosphoric anhydride tubes should have a preliminary heating in a vacuum to eliminate the impurity. This may be done with several tubes at a time, when they can be sealed at each end and preserved for future use.

It is thus seen that this blue glow is due to some impurity in the phosphoric anhydride. Likewise I have shown from the examination of its spectrum that it is not due to phosphorus. The glow probably is due to some intermediate oxide of phosphorus. In any accurate work with the mercury pump, where phosphoric anhydride is used as the drying agent, this source of impurity must not be overlooked.

An addition to the apparatus was made, a supplementary tube sealed on containing a grain of corrosive sublimate. This was used as being non-volatile at the ordinary temperature, but easily vaporised by heat. The experiment last described was continued, and immediately after the phosphoric blue edge appeared fresh hydrogen was let in and exhaustion continued till the faint blue was eliminated. The mercury salt was then heated, when immediately a rich blue edging appeared on the face of each pink stratification and the yellow lines of mercury shone out distinctly. Mercury blue is of a fuller colour than that of the phosphoric blue.

Conclusions; Chiefly Theoretical.

The phenomenon of blue faces on the pink discs is probably due to some such action as the following:—At the exhaustion necessary to give stratifications, there is a wide dark space round the negative pole. Here the negative electrons (radiant matter), issuing from the pole with enormous velocity, have sufficient energy to clear a space in front of them to a distance varying with the degree of exhaustion.

Dr. A. Schuster considers that the discharge through mercury vapour in a vacuum tube, when quite free from air, will not give rise to stratifications, or to the dark negative space.[1] My own experiments (*Journ.* of the Inst. Electrical Engineers, vol. xx. p. 44) show that the dark space will form in pure mercury vapour. Whichever view may be correct, there is no doubt that if stratifications in mercury vapour are not altogether unknown, they are much more difficult to produce than similar phenomena in hydrogen or other diatomic gases. At a certain critical stage of the exhaustion, when both hydrogen and mercury are present, I obtain both mercury and hydrogen strata.

It is known that in a vacuum tube, at an exhaustion approaching the stratification-point, any slight obstruction, such as constriction in the tube, or a series of wires sealed in, will cause luminous strata to hang round the obstruction. In a similar way, the hydrogen strata afford an anchorage, as it were, for the mercury, each hydrogen luminosity having a little blue glow of mercury hanging on to it; whereas, were there no hydrogen, no mercury stratifications would be seen.

The pink and blue luminosities show where the electrons and gaseous atoms meet; when the speed of the electrons is suddenly diminished, the shock throws the atom into greater vibration, which, being communicated to the ether, produces vibrations of definite wave-lengths, constituting the special spectrum of the atom. The dense mercury atom is not driven back so much as the lighter hydrogen atom—hence the blue front to the pink buttons. A very little difference in the exhaustion suffices to break the adhesion between the mercury and the hydrogen; then the mercury vapour diffusing along the tube meets the electrons from the negative pole and is swept back to the head of the hydrogen strata, and becomes apparent as a single button of blue light.

Radiant Matter. Electrons.

I have spoken of "radiant matter" and "electrons" as if they were identical. Nearly twenty-five years ago I was led by experiments in highly rarefied tubes to assume the existence of matter in an *ultra-gaseous* state. Later, in a lecture delivered before the British Association at the Sheffield Meeting, 1879 (*Chemical News*, vol. xl. pp. 91, 104, 127), I first used the expression "radiant matter," or matter in the ultra-gaseous state, to explain the novel phenomena of phosphorescence, trajectory, shadows, mechanical action, magnetisation and intense heat. "In studying this fourth state of matter," I said, "we seem at length to have within our grasp and obedient to our control, the little indivisible particles which with good warrant are supposed to constitute the physical basis of the universe. We have seen that in some of its properties radiant matter is as material as this table, whilst in other properties it almost assumes the character of radiant energy. We have actually touched the borderland where matter and force seem to merge into one another" (*Chemical News*, vol. xl. p. 130).

In twenty-five years one's theories may change, although the facts on which they are based remain immovable. What I then called "radiant matter" now passes as "electrons," a term coined by Dr. Johnstone Stoney, to represent the separate units of electricity, which is as atomic as matter. What was puzzling and unexplained on the "radiant matter" theory is now precise and luminous on the "electron" theory. Thus my early hypotheses fall into order by the substitution of one expression for the other. A chemical ion consists of a material nucleus or atom of matter constituting by far the larger portion of the mass, and a few electrons or atoms of electricity. The electrons are the same as the "satellites" of Lord Kelvin and the "corpuscles" or "particles" of J. J. Thomson.

Electrons probably leave the negative pole with a velocity nearly uniform, modified to a considerable extent by the degree of exhaustion, and to a less extent by the electromotive force behind them. Many experiments—the details I must leave to a future occasion—show that the liberated electrons do not behave as a gas, *i.e.* they have not properties dependent on inter-collisions, mean free path, &c.; they act more like a fog or mist, are mobile and carried about by a current of air to which they give temporary conducting powers, clinging to positively electrified bodies and thereby losing mobility, and settling on the walls of the containing vessel if left quiet.

[1] Dr. A. Schuster, "Experiments on the Discharge of Electricity through Gases," *Roy. Soc. Proc.*, vol. xxxvii. p. 318.

On the other hand, the crowd of hydrogen or mercury atoms, by virtue of molecular motion and inter-collisions, act as gases. Whilst their *mean* free paths are conditioned by the degree of exhaustion, there may be amongst them a certain number of *actual* free paths differing widely on each side of the mean. Under the influence of the electromotive force, and at the right degree of exhaustion, these atoms arrange themselves in groups,[1] while the rushing swarm of electrons driven from the negative pole meet them and render them visible. According to J. J. Thomson, the mass of an electron is about the 1/700th part of that of the hydrogen atom, and as these masses start from the negative pole in a vacuum tube with a velocity of the order of half that of light, it is easy to see that their heating, phosphorescent and mechanical power must be stupendous.

The basis of the electron, as I foreshadowed in 1879 in the case of radiant matter, is probably the same in all cases—the protyle from which the chemical atoms were assumed to be formed.

On the two-fluid theory, the electrons constitute free negative electricity, and the rest of the chemical atom is charged positively, although a free positive electron is not known. It seems to me simpler to use the original one-fluid theory of Franklin and to say that the electron is the atom or unit of electricity. Then a so-called negatively charged chemical atom is one having a surplus of electrons, the number depending on the valency, whilst a positively charged atom is one having a deficiency of electrons. Differences of electrical charge may thus be likened to debits and credits in one's banking account, the electrons acting as current coin of the realm.

SCIENTIFIC WORK OF THE GERMAN ANTARCTIC EXPEDITION.[2]

THE head of the German Antarctic Expedition, Prof. Dr. Drygalski, has sent from Cape Town to the home authorities a number of full reports on the work which had been carried on by the expedition up to the date of their despatch. As is well known, the ship, which had been specially built for the expedition, was long overdue at Cape Town, and her protracted non-appearance gave rise to some anxiety. We give the following extracts from the official report, which will shortly appear, in order to furnish evidence of the activity of the staff, and of the reasons for the great protraction of the voyage.

In the scheme of operations for the expedition, it had been arranged that visits to two land stations should be made during the voyage to Cape Town, in order to determine, by fresh comparisons with the absolute magnetic elements at those land stations, the changes in the magnetic character of the ship since its determination at Kiel before sailing. The magnetism of a new ship is always subject to changes in course of time, but these changes are more especially caused by change of magnetic latitude as the ship passes from one hemisphere to the other. With this object, the following places were selected as apparently desirable :—The Cape Verdes or Madeira, north of the magnetic equator, and Bahia or Ascension to the south of it.

After consultation with the magnetician of the ship, Dr. F. Bidlingmaier, I had selected Porto Grande in St. Vincent and Ascension. If, for any reason, Ascension proved to be inaccessible, it seemed advisable to adopt the usual plan, on board ship, and determine the deviation by swinging the ship on eight different courses in the open sea. During our stay at Porto Grande, which lasted until September 11–16, the magnetic observations were our principal business, and we succeeded in determining, on board the ship, the deviations in the Magnetic Declination, Total Force, and in Horizontal and Vertical Force due to her magnetism.

I myself landed, with two assistants, and set up a tent near the spot where the shore magnetic observations were being carried on, in order to secure time observations to rate our chronometers and watches, and also to make some observations of the force of gravity. Owing to the weather, we could make no astronomical observations.

My orders for the next part of the voyage were to cross the equator on the 18th meridian, and then to make for Ascension. The object of the first position was to verify the sounding of 7370 metres (4030 fathoms) [the greatest depth on the line], which had been obtained by the French man-of-war *La Romanche* in 0° 11′ S. and 18° 15′ W. As this figure is not mentioned on the British charts of soundings, nor in the recent critical representation of sea depths, by Prof. Dr. Supan, I therefore wished to trace its possible connection with the great depths of the Brazilian basin.

The visit to Ascension was to attain the objects above named. It was evident enough that the carrying out of this plan would present some difficulties, for the usual sailing track to the Cape (which was best for our ship, owing to the low power of her engines, which would not allow of steaming against the S.E. trade with its accompanying sea) crosses the equator far to the westward, probably as far as the 25th meridian. A visit to Ascension would entail our steering a south-easterly course immediately on leaving the Cape Verde, so as to be able to make a south-westerly course to the island under sail. The course indicated was to be first tried and tested as to whether it would take too much time. We crossed the belt of calms under steam, between the two trade winds. In this swell the *Gauss* rolled, at times very heavily, so that much glass or other breakable articles in the laboratory came to grief, while the ship, under sail, even with a stiff breeze and a good deal of sea, had been remarkably steady. This swell retarded our progress considerably, as of course our speed was greatly reduced. This was aggravated by increased fouling of the bottom. As the ship was very low in the water, the screw well, through which the screw and rudder could be lifted, on meeting ice, so as to preserve them from damage, may have contributed to the prolongation of the voyage. In short, we proceeded very slowly along the prescribed track, where the wind failed us, and the currents at least gave no help, though the engines worked perfectly, and gave promise of a very satisfactory performance whenever we should come into a state of sea checked by the presence of ice.

All these impediments retarded us with enhanced insensity when we met the S.E. trade on the line. This was very fresh (and we should have liked to have had a similar force in the N.E. trade), but we could make no use of it, as it was dead ahead on our course for Ascension, and it brought with it a trying swell and current. The rate of the ship got less and less, and at last stopped entirely on October 5. In these circumstances, as time was getting on (we crossed the line a few days after the entry of the sun into south declination on October 1, so that we ran directly from the northern into the southern summer), it seemed therefore desirable to reconsider our plan and give up the Ascension visit entirely, and so on October 6 I decided to do this and use the existing S.E. trade for a run to the Cape, starting on that day. As soon as we changed our course we made at once a speed of six or seven knots. On October 7 we disconnected the engines and made sail, but the wind did not last. On October 9 the S.E. wind died away, and these light winds continued, with some slight exceptions, up to Cape Town. The *Gauss* always made very short daily runs, so that we had a very long passage. The light winds and fair weather were the cause, as we had only one storm, November 18–20, just at the end of the voyage. We were naturally obliged to husband our coal so as not to lighten the ship too much.

On October 30, the after steam capstan was connected with Prof. Vanschöffen's vertical net, which was at a depth of

[1] In an address delivered before the Institution of Electrical Engineers, January 15, 1891, I gave an outline of a theory of stratifications in rarefied gases. The following quotation renders my meaning clear:—"If, in any much-frequented street, at some time when the stream of traffic runs almost equally in both directions, we take our stand at a window from which we can overlook the passing crowd, we shall notice that the throng on the footway is not uniformly distributed, but is made up of knots—we might almost say blocks—interrupted by spaces which are comparatively open ; we may easily conceive in what manner these knots or groups are formed: some few persons walking rather more slowly than the average rate slightly retard the movements of others, whether travelling in the same or in an opposite direction. Thus a temporary obstruction is created. The passengers behind catch up to the block and increase it, and those in front, passing on unchecked at their former rate, leave a comparatively vacant space. If a crowd is moving all in the same direction, the formation of these groups becomes more distinct. Hence mere differences in speed suffice to resolve a multitude of passengers into alternating gaps and knots. Instead of observing moving men and women, suppose we experiment on little particles of some substance, such as sand. If we mix the particles with water in a horizontal tube and set them in rhythmical agitation, we shall see very similar results, the powder sorting itself with regularity into alternate heaps and blank spaces. If we pass to yet more minute substances, we observe the behaviour of the molecules of a rarefied gas when submitted to an induction current. The molecules here are free, of course, from any caprice, and simply follow the law I seek to illustrate, and though originally in a state of rampant disorder, yet under the influence of the electric rhythm, they arrange themselves into well-defined groups or stratifications."—*Journ.*. of the Inst. Electrical Engineers, vol. xx, p. 10.

[2] Based upon an Article in *Der Tag*, Berlin, January 25.

2000 metres, and above it hung my deep-sea thermometers and five or six buckets, at the depth of 1500 metres. As each bucket came up, Dr. Gazert and Dr. Philippi speedily emptied it of its contents to search for bacteria and determine the amount of contained gas. Dr. Bidlingmaier, on the captain's bridge, regulated his registering apparatus in the meteorological screen, while Captain Ruser, beside him, kept the ship heading the swell and watched that the deep sea lines should not get foul and that the ship should not overrun them. The chief engineer, Stehr, on the after bridge watched the sounding apparatus with me. The first officer looked after the line as it came up and quickly dismounted the attached instruments. Vahsel saw to the running of the windlass itself, and Ott, in the small dinghy, picked up a huge albatross which Dr. Gazert had shot, and which was at once dissected by the practised hands of Dr. Werth. Then came up Dr. Stehr's question as to how many wheels were running on board at once, without actually counting them.

On Saturday, November 23, we reached Cape Town, having made some magnetic observations near the coast. On Saturday, December 7, the expedition will start again.

I can only say, in conclusion, that we shall never forget the warmth of the reception we met with, not only from the Imperial Consul-General von Lindequist, the members of his staff and the German colony, but also from the officials and scientific men of Cape Town, which rendered our stay there particularly pleasant.

THE USE OF ANATOMICAL CHARACTERS IN THE IDENTIFICATION OF WOOD.[1]

THE chief contributions to the study of the secondary wood of plants have been made by students of forestry, amongst which the names of Nördlinger, Hartig, Brandis, Gamble, and of many men connected with the Indian Forestry Department, deserve our respect. The school of Radlkofer (especially Solereder) has done good work in connection with the structure of the primary wood, which throws many sidelights upon that of the secondary wood, yet there is much less help to be derived from their studies than one would suppose, because there is frequently much difference in the structure of the two classes of tissue.

The grouping of the vessels and the medullary rays and the arrangement of the wood-parenchyma are frequently so characteristic that various genera can be recognised by a glance at the transverse section, *i.e.* horizontally as the tree stands; and, further, it is by no means rare to find the same structure running through a whole genus or, less frequently, through a whole order. A hundred genera could be cited which exhibit a strong family likeness, and of the Proteaceæ and Sapotaceæ it may be said that the description of the structure of the wood of one species will practically serve for the whole order. On the contrary, there are orders which appear to consist chiefly of exceptions, as in the case of the Celastraceæ, where it is difficult to find two genera with any important feature in common. The structure of the woody portion of cryptogams has been employed for years in the study of fossil plants; that of the monocotyledonous trees and of the conifers is notoriously uniform, and is as sure a guide to their position in the natural system as any external character. Why then should not the same rule apply to the angiospermous dicotyledons, and for what reason should the thread be lost as soon as we pass from one division of the vegetable world to another? It seems a by no means extravagant idea that, inasmuch as it is quite indifferent to the welfare of a plant what the structure of its woody portion may be so long as it performs the mechanical duties imposed upon it, ancestral traits should be preserved undisturbed in the wood more than in any other part.

Ignoring this debatable question there is no doubt whatever of the economic importance of this study. There are not only so many kinds of timber in use in Europe and elsewhere, but there are great numbers which are destined to become useful, together making a variety with which no timber dealer can keep *en rapport* by the old method of rule of thumb. It is still more difficult in the colonies and in new countries to tell one wood from another, because the number of persons possessing the necessary training is smaller than at home. The popular and vernacular names are in many places so frequently duplicated or misapplied that they are useless as guides unless the structure of the wood be taken into account. Instances could be multiplied in which wrongly named timbers have been referred to their proper titles, and of inquiries for unknown woods being directed into the proper channel, and of cases in which attempted deception has been frustrated by the anatomical method.

For practical purposes it is rarely necessary to use high powers of magnification or to study the sculpture upon the walls of the cells. A pocket lens or a two-inch objective will frequently suffice to display the special character of the structure. If higher powers be used this individuality, as I may call it, is lost, as it is dependent upon the arrangement or complex of the elements. For instance, the radial or tree-like arrangement of the vessels in the wood of all the trees of the genus Quercus is recognisable by the naked eye, but it fails to be striking when viewed under a half-inch objective. This particular feature may be traced through the genera Corylus, Castanea, Ostrya, Castanopsis and Carpinus, but not in Fagus. The concentric undulating lines of vessels characteristic of the elms are also usually visible to the naked eye and can be traced in every

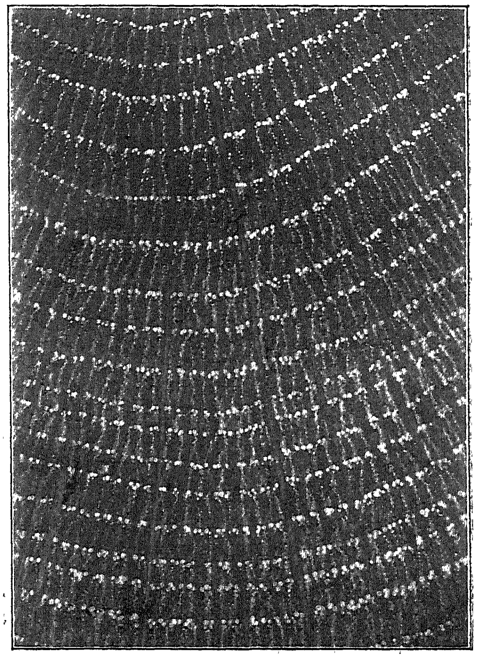


FIG. 1.—Oak. Transverse section × 3½.

species of Ulmus and, in a modified form, in Celtis, also in Ficus, Morus, Artocarpus, Maclura and Urtica.

It may at once be conceded that anything like a natural system of classification of woods by their structure is quite impossible at present. There are too many glaring exceptions and there is too little recorded information. Out of sixteen species of Caprifoliaceæ examined,[1] fifteen have the same type of structure, while the remaining one, *Viburnum Tinus*, L., is quite different; while out of nineteen species of Celastrus there were found no less than seven distinct types of structure.

Nevertheless, amongst such a number of different woods a guide to enable one to trace the name of any wood is a crying need, and several authors have attempted with more or less success to satisfy it. There are several by which the European woods may be identified, notably those by Mathieu, Hartig, Schwartz and Nördlinger, that of the latter embracing exotic woods also, to the number of 1100. Unfortunately, Nördlinger, whose work is otherwise unrivalled, relies upon the definiteness or indefiniteness of the boundary of the year's growth of wood in too great a degree, hence the student is led astray. Alfred Ursprung has recently shown how elusive this

[1] Based upon a paper read before the Society of Arts on December 4, 1901, by Mr. Herbert Stone.

[1] Sambucus, 2 species. Viburnum, 6 species. Lonicera, 8 species.

character is. From the examination of some 1500 species I am convinced that the character of the medullary rays (which, by the way, are anything but medullary in the secondary wood) is the most constant feature and should form the basis of an artificial key, but it separates the genus Betula, the rays of which are but a millimetre high on a vertical section from Alnus, where they may run to inches, and it cuts the Leguminosæ into two halves, one of which has bold spindle-shaped rays in transverse section (Ulex, Cytisus, &c.), while in the other the rays seem to meander amongst the vessels like so many limp threads (Mimosa, Gleditschia, &c.).

Nevertheless, a useful key may be constructed by first distinguishing those woods with two kinds of rays (many Cupuliferæ) from those having but one. The latter then fall into two groups, one having rays which have intervals between them of not less than the transverse diameter of the largest pores present, the other conversely having the intervals between the rays never greater than the pore-diameter, *i.e.* the rays diverge and run round or avoid the pores. These two types of rays are very clearly marked and have quite different aspects. The arrangement of the vessels or pores can then be usefully employed, as the concentric radial, tree-like or undulating groups, or uniform distribution of the pores is very constant in many genera, as are

FIG. 2.—Common elm. Transverse section ×3½.

also the equally varied forms assumed by the soft-tissue (wood-parenchyma), which comes next in order of importance. It would be out of place here to go into further detail, and it need only be pointed out that by following this sequence all members of the same genus except the aberrant forms fall together into the same ultimate group, which is not the case with Nördlinger's or any other key that I have used.

Many groups, or even whole genera, are so similar in structure that their species can only be distinguished by long acquaintance, *e.g.* Fraxinus, Acer, &c., and it is then necessary to have recourse to other features, such as the specific gravity, colour, smell, taste, hardness, behaviour with certain reagents, colour of their solution with water and alcohol, &c. Frequently these are so pronounced that a single feature may be sufficient to describe a species, as, for example, the offensively powerful cheese-like smell of *Goupia tomentosa* and the flinty hardness of *Lignum vitae*, hence it has often been urged that if a wood can be so readily identified by such simple means, why employ a more complicated and less accessible method. No one underrates obvious characters, but there are thousands of species, hundreds of which are employed in the arts, that have no pronounced feature of this kind to distinguish them. The value of the anatomical characters to the systematic botanist and to the trader is, however, in inverse proportion. The closer the resemblance in structure between the members of the same group the stronger the claim for a place in classification. On the other hand, the greater the dissimilarity the easier becomes their discrimination for commercial purposes.

CONFERENCE ON SCHOOL GARDENS.

A CONFERENCE on school gardens was held under the auspices of the Berkshire County Technical Education Committee at Reading College on Saturday. Mr. T. G. Rooper, one of His Majesty's inspectors of schools, read a paper on "School Gardens in England and in Germany," giving an account of those he has helped to institute in this country and others which he visited on the Continent. He dwelt, too, upon the provision made in Germany at the Pomological Institute for training elementary teachers, and one of his most interesting points was with regard to them. They are not, as here in England, expected in return for tuition, maintenance and travelling expenses, to attend courses of instruction during well-earned holidays, but they have the additional privilege of working at the Institute during term time, a substitute being paid to take their duty.

English school gardens, though at present comparatively few in number, are on all sides acknowledged to be the most practical yet instituted. Except in the case of those attached to continuation schools, no attempt must be made to utilise them for the technical teaching of gardening or otherwise than as mere training, mental and manual. A point obvious enough that was touched upon was that inspectors of schools should know something of horticulture if they are to report on school gardens and these are to be instituted in larger numbers. The importance of it is that, with very few exceptions, the inspectors are not at all well versed in the subject. County Councils cannot spend money directly upon elementary schools, but training of teachers they can arrange for, they can hold conferences such as the one here discussed, and their horticultural instructors may, and do, without breaking the law, give advice on the laying out of school gardens. Mr. J. C. Medd, in the course of his remarks, alluded to the Nature-Study Exhibition, with a view to holding which in London during next summer an association has just been formed. At this, which if it comes about will be greatly due to Mr. Medd's efforts, garden produce that may be in the proper condition at the time will no doubt be welcomed. Sir John Cockburn, lately Premier and Minister for Education in South Australia, is the chairman of the executive committee. Sir John, speaking at the Conference, alluded to "Arbor Day," upon which everyone in the antipodes who can plants a tree. The idea, one might say, is borrowed from America and is a very good one.

The difficulty of getting proper time for practical work was also touched upon by Sir John Cockburn, who said that, although one hour was all he could obtain at first, nevertheless, before he left South Australia, schools had been started in which only half the time was devoted to theoretical instruction.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

OXFORD.—At the 232nd meeting of the Junior Scientific Club on Wednesday, February 12, two papers were read, viz. "Colour and Chemical Composition," by Mr. S. A. Ionides, Balliol College, and "The Centrosome," by Mr. A. D. Darbishire, Balliol College.

By his will, Sir J. H. Gilbert, F.R.S., who was Sibthorpean professor of rural economy from 1884–90, and who died on December 23, 1901, bequeathed the portrait of himself by his brother, Josiah Gilbert, to the University of Oxford, to be placed in the library of the Sibthorpean professor of rural economy.

DR. F. T. TROUTON, F.R.S., of Trinity College, Dublin, has been appointed Quain professor of physics in University College, London, in succession to Prof. H. L. Callendar, F.R.S.

DR. W. H. WILLCOX has been appointed deputy lecturer in hygiene at Bedford College for Women, on the resignation of

Dr. W. C. C. Pakes, who has been appointed bacteriologist to the Transvaal Government. The council has resolved that, in order to keep a permanent record of the legacy left to the college by Mrs. Morton Sumner, the lecturer in geology be hereafter called the Morton Sumner lecturer in geology.

THE papers read at the recent conference of science teachers, arranged by the London Technical Education Board, are appearing in the *Technical Education Gazette*, with reports of some of the speeches. The January number of the *Gazette* contains addresses on the teaching of hygiene, by Miss A. Ravenhill; mental school hygiene, by Dr. F. Warner; and the teaching of natural history, by Mr. F. E. Beddard, F.R.S.

THE Technical Education Board of the London County Council report that the reorganisation of London University is already having a marked influence for good on the polytechnics and other institutions. The advanced classes in science and engineering are being revised and brought up to a higher standard, gaps in the curriculum are being filled up, and more students are being induced to enter upon systematic courses of study, extending over three or four years, instead of attending isolated classes. Complete degree courses, under teachers of the University, will shortly be available for evening students at several of the polytechnics. The due recognition of engineering and higher commercial subjects was provided for by the establishment of separate faculties, and the Senate has now approved courses of study in which students will proceed to the degrees of B.Sc. and D.Sc. The regulations for the economic or commercial degree enable it to be gained in such subjects as the history, principles and organisation of banking, insurance, railway and shipping transportation, international commerce, local government, statistics, &c. By means of the Council's aid, the Senate has now determined on (1) the organisation of an institute of advanced chemistry, both organic and inorganic, at one centre; (2) the provision of advanced teaching in engineering at two centres; (3) the systematic organisation of the teaching of modern languages at all the University centres, including the polytechnics, and beginning with German; (4) the provision of a professorship of education in connection with the Council's proposed day training college for teachers; and (5) the appointment of University teachers in economic history and theory, commercial geography and history, banking, statistics, foreign trade, &c.

SCIENTIFIC SERIAL.

Bulletin de l'Académie de Sciences de St. Pétersbourg, 5th series, vol. xii.—On the compound (so-called stationary) radiants of shooting stars, by Th. Bredikhine (in French). The supposed existence of stationary radiant points (or radiant points of long duration) is an obstacle against all more or less admissible theories of shooting stars. Taking advantage of the 918 meteoric orbits calculated by J. Kleiber in 1891, and of subsequent data, the author concludes that each stationary (or long duration) radiant consists of several individual radiants, even when these radiants do not much differ from each other in their dates; this means that each stationary radiant is a compound radiant which originates from several individual radiants, each of which has its own position in space and its own origin, and all of which are intersected by the orbit of earth. Thus, in the well-known radiant of β Persei he finds "thirteen or fourteen different orbits, *i.e.* as many different streams" (p. 102). The author examines next the theories of Profs. H. H. Turner and A. S. Herschel, and concludes that "the deductions of Prof. Turner are only admissible under the impossible supposition that the earth moves with a uniform speed along a straight line. But if the theory itself is inconsistent, its secondary complications, such as the spinning of the meteoritic stream, the resisting medium, &c., have no more signification" (p. 115). Applying his explanation next to the polar stationary radiants of Mr. Denning, the author shows that in the radiant ζ Draconis (No. 36 of catalogue A), one may recognise "twelve different individual streams (twelve comets) apparently composing one single stationary radiant." The author's final conclusion is:—"A stationary radiant does not originate from a single individual stream or from one single comet; it must be named a compound radiant, because it is produced by several comets or independent streams. The phenomenon is so simple that all complicated and artificial theories are useless and superfluous. . . . Thanks to the numerous and careful observations of Mr. Denning, the phenomenon has lost its supposed individuality and has become decomposable and explicable."—On photographic observations of the satellite of Neptune at Pulkova, by S. Kostinsky (Russian; with a plate).—Report on zoological researches at Sebastopol in 1899, by A. Kovalevsky: hypodermal fertilisation with the leeches; on *Batracobdella latastii*; on *Helyle Tyrtowii* (n.sp.); on *Pseudovermis paradoxus*, Periasl.—On faint lines in stellar spectragrams, by A. Belopolsky.—On a MS. in Coptish language attributed to Dionysius Areopagita, by Oscar Lemm.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, January 23.—"Mathematical Contributions to the Theory of Evolution. XI.—On the Influence of Natural Selection on the Variability and Correlation of Organs." By Karl Pearson, F.R.S.

The influence of directed—natural or artificial—selection on the characters of a race is one which it is fundamental for the purposes of evolution to appreciate quantitatively. I have already shown in an earlier memoir of this series the effect of random selection, or what it is better to term random sampling, on the characters of a population. Isolation of a few individuals who form a random sample may produce very sensible modifications of race characters, but it is to directed selection that we must look for changes on the largest scale. The subject is a very broad and complex one—no less than the total effect upon a population containing individuals at all ages of a selective death-rate applied for a long period and a function not only of the organs of each individual, but of the relationship of these organs to each other, and of the stage of growth of the individual. In the present memoir, attention is confined to the influence of selection in altering a complex of organs, no reproduction taking place during the selection.

A very definite distinction is at once reached, namely, that between directly and indirectly selected organs. It may be said that, although it is possible for the recruiting sergeant to select stature, and in so doing differentiate the arm-length of his troop from that of the general population, yet that in natural selection we are given only the modified organs, and so we cannot tell which of them have been directly and which indirectly selected. Both are changed; how discover which was the source of the change? The answer is: In the same manner as we could distinguish between two recruiting sergeants, one of whom selected his troop from the general population by stature, and the other by cubit; in either case the stature and cubit would be both modified, but the mathematical theory of regression would enable us to distinguish between the methods of operating of the two men, and even between them and one who selected by *both* stature and cubit at once. The mathematical theory as developed in this paper shows us that, although the whole complex of characters may have been changed, still, if direct selection has only occurred in p out of n possible cases, there will be certain of the partial regression coefficients which remain unmodified and which will theoretically enable us to distinguish among the whole group of differentiated organs, between those directly selected and those modified only because they happen to be correlated with the directly selected organs. Thus the distinction becomes one of singular importance, for though the selection of a few organs modifies the means, variabilities and correlations possibly of the whole complex of characters, certain functions of those quantities remain constant, and such constants ought to be discoverable, at any rate in theory, and should serve as the criterion of a common origin, when we deal with local races as having been subjected only to a selection *directly* differentiating a comparatively few characters.

If selection has changed a race from a condition A to a condition B, it becomes of much interest to determine the nature of the selective death-rate by which the process has been carried on, and it is found that this death-rate as represented in the surface of survival rates enables us to distinguish two kinds of selection, termed in the memoir positive and negative selection. In the first case, a race is modified, because the nearer its members are to having their organs with a certain system of values, the better fitted they are to survive; in the second case, the nearer the individuals are to this system the less fitted they

are to survive. There will usually be in this second case, not a single system, but an indefinite number of systems which would equally well fit individuals to survive; in the first case, on the other hand, there are an indefinite number of systems which equally unfit their owners for surviving. This distinction seems of considerable interest.

For example, to select from the French race a race in femur and humerus like the Aino, we should have to proceed by a positive selection; but to select from the Aino a race like the French, we should have to proceed by a negative selection. To get 1000 Aino we should have to select for these two organs alone out of some 6,000,000 Frenchmen, but to get 1000 Frenchmen from the Aino we must select from about a billion of the latter. Thus we are to some extent able to appreciate the stringency of the selection, which even lasting through long ages, and introducing continuous reproduction, would be needful to enable us to pass in the case of only two organs from one race to the other. Another point brought out by the surface of survival-rates is the fact that the fittest to survive are usually not the most frequent survivors.

It will be seen that the memoir opens up a novel field of investigation, but one so wide that the theory of it must be limited by close contact with what is needful for the purposes of evolution. We want measurements on the local races of animals to guide us; at present we know scarcely in any one case whether differentiation has taken place by *direct* selection of few or of many organs. When once such measurements are forthcoming we shall have firmer ground to go upon, and the processes of the present memoir seem to suggest how in the future we shall be able to link together quantitatively local races, and possibly at a more remote date obtain quantitative conceptions of the stages of evolutionary descent itself.

January 30.—"The Specific Volumes of Oxygen and Nitrogen Vapour at the Boiling-point of Oxygen." By James Dewar, M.A., D.Sc., LL.D., F.R.S.

In a paper on "The Boiling-point of Liquid Hydrogen determined by Hydrogen and Helium Gas Thermometers" the author pointed out that a constant-volume gas-thermometer filled with oxygen gas, having a pressure at 0° C. of about 800 mm., gave a very accurate value of the boiling-point of liquid oxygen. As it seemed advisable to confirm this result indirectly, an attempt was made to determine the vapour density of oxygen at its boiling-point by direct weighing, the intention being, if the experimental results proved at all encouraging, to repeat the work on a larger scale and with greater precautions. As at present there is no likelihood of the more accurate determinations being made, the results of the preliminary inquiry are presented to the Society. They give in any case, with considerable accuracy, the specific volumes which have never been directly determined.

In order to obviate any question of the buoyancy of the air, two flasks A and B of as nearly as possible the same air displacement were counterpoised on an Œrtling balance. The B flask remained permanently on one scale of the balance during all the weighings, while the A flask was weighed, either exhausted or filled with oxygen (or nitrogen), in various circumstances according as the experiments required.

As the intention was not only to ascertain the density of oxygen and nitrogen at their respective boiling-points under atmospheric pressure, but also under diminished pressure, experiments were made with nitrogen at ordinary temperatures and at pressures varying from about one-sixth of an atmosphere to ordinary pressures, in order to find the range of variation in the results with the 316 c.c. flask to be used in the subsequent low-temperature experiments.

Experiments with nitrogen give a mean value of 1·260 grammes, at standard temperature and pressure, as the weight of a litre of the gas. This is about a quarter per cent. higher than the accepted value of 1·257. The extreme variation in the individual experiments is about half a per cent. The average value of the results under about one-third of an atmosphere is 1·266 grammes, the tendency under the low pressures being to make the density half a per cent. higher. Considering that in the actual low-temperature experiments the mass of gas to be weighed would be at least three times greater, it was inferred that in spite of difficulties of manipulation and corrections, the results might be anticipated to lie within a half per cent. of the true value.

The mean weight, given by six experiments, of one litre of oxygen vapour at 760 mm. and 90°·5 absolute was found to be 4·420 grammes, and the specific volume 226·25 c.c. If the first two experiments are eliminated on the assumption that the proper equilibrium of temperature had not been attained, the average weight per litre would become 4·428 grammes, and the specific volume 225·82.

Taking Regnault's density of oxygen at 0° and 760 mm., the density at 90°·5 in the ordinary way would be 0·0043137, and the specific volume 231·82 c.c. Thus the volume given by the ordinary gaseous laws is 1·0246 times the average observed volume; or we may put it that pv is diminished at the boiling-point of oxygen by 2·46 per cent. Again, while the ratio of the absolute temperatures is 3·017, the ratio of the densities is 3·091.

Further experiments were made on oxygen vapour at 90°·5 and under reduced pressures. If the first three experiments are averaged (the pressures being close together), the weight of a litre of oxygen at 90°·5 absolute under a pressure of 282·5 mm. would be 1·5982 grammes. The ratio of this density to the value previously found for one atmosphere pressure, viz. 4·42 grammes, is 2·765, and the ratio of the pressures is 2·690. It appears that the ratio of the change of density of the vapour of oxygen at 90°·5 absolute, under variable pressure, is greater than the ratio of the change of pressure. It is clear, however, that it would be necessary to work upon a larger scale in order to get satisfactory vapour densities at low temperatures under pressures below that of the atmosphere.

Observations were made on the density of nitrogen vapour at the boiling-points of liquid oxygen and liquid air respectively.

Two experiments were made with liquid oxygen taken to be at temperature 90°·5 absolute. Four experiments were made in one and the same sample of liquid air, with rising temperature. The first two experiments made with liquid oxygen give a ratio of the nitrogen densities from the author's own values of 3·088, the absolute temperature ratio being 3·017, his values for the ratio of the oxygen densities for the same range of temperature being 3·091 as previously deduced. It may be safely assumed that if the density of nitrogen were observed at its boiling-point it would deviate as much from the ordinary gaseous laws as oxygen. Further, the specific volume of nitrogen at its boiling-point of 78° absolute would from the above formula be 221·3 as compared with 226·2, the similar value found for oxygen.

The general inference to be drawn from these preliminary experiments is that trustworthy vapour densities may be determined at very low temperatures. There seems to be no reason why the vapour density of hydrogen at its boiling-point should not be accurately ascertained; only, as in this case the internal pressure in the weighing flask would amount to nearly fifteen atmospheres, it would be advisable to construct the flask of some metal or alloy. A flask of the size used in the oxygen experiments filled with the vapour of hydrogen at its boiling-point would be equivalent in weight to between four and five litres of hydrogen at the ordinary temperature and pressure, and such an amount of material ought to give density results at the boiling-point of hydrogen of considerable exactness, notwithstanding the great manipulative difficulties that would necessarily be involved in the execution of such a determination at 21° absolute.

Physical Society, February 14.—Annual General Meeting.—Mr. T. H. Blakesley, vice-president, in the chair.—Prof. S. P. Thompson, F.R.S., was re-elected president. Prof. S. P. Langley and Prof. H. A. Lorentz were elected honorary fellows to fill the vacancies caused by the deaths of Prof. Rowland and Dr. Koenig. The president of the German Physical Society was elected an *ex-officio* fellow of the Society.—The secretary then read the president's address. It commenced by giving some particulars of the life and work of Rowland, Koenig, Langley and Lorentz. On January 11 a telegram was sent, in the name of the Society, to Prof. Hittorf congratulating him upon the jubilee of the professoriate. The work of translation, revision and production of an English version of Gilbert's "De Magnete" has been completed, and a copy of the book presented to the Society by the president. The remainder of the address dealt with the refusal of the law of this country to recognise as valid matter for the granting of letters patent anything which may have been brought before any of the learned or scientific societies. In the United States a man may appeal to the fact of his having read such a paper in proof of his subsequent claim to receive a valid patent for his

nvention. The law in this country works very inequitably. As examples, the invention of the microphone by the late Prof. Hughes, the president's invention of the "astigometer" and the invention of wireless telegraphy by Prof. Lodge were given. —An ordinary meeting of the Society was then held, at which Mr. Littlewood exhibited an Attwood's machine.—The Society then adjourned until February 28.

Chemical Society, February 6.—Dr. Armstrong, F.R.S., in the chair.—An investigation into the composition of brittle platinum, by Prof. Hartley, F.R.S. Platinum points repeatedly heated in the course of dental practice become very brittle, owing, the author believes, to the presence of minute quantities of carbon and phosphorus, although such impurities could not be definitely detected.—Conversion of 1-hydroxycamphene into β-halogen derivatives of camphor, by Dr. M. O. Forster. The author finds that his supposed "enolic" form of camphor is really 1-hydroxycamphene, and has studied the action of halogens upon it, so obtaining the various β-substituted camphors.—Tetrazoline, ii., by Messrs. Ruhemann and Stapleton. The action of methyl iodide upon this substance gives rise to several derivatives of unknown relation to tetrazoline.—The solubilities of the calcium salts of the lower fatty acids, by Dr. Lumsden. The author has investigated the influence of temperature upon the solubilities of these salts, and has shown that, with the exception of the formate, they decrease in solubility with increase of temperature. The salts of the normal acids show increasing solubility as the series is ascended, but are less soluble than the corresponding *iso*-salts.—The equilibrium between a solid and its saturated solution at various temperatures, by Dr. Lumsden. The solubility of a substance is affected by three factors—the solution pressure of the dissolved molecules, the thermal energy of dissociation of the substance, and the affinity, if any, of solvent and solute. The solubility curve (temperature, weight of substance) may be regarded as expressing a series of equilibria between these influences at the various temperatures included in the curve, and from this point of view it is shown that the solubility curves of calcium salts are not abnormal.—On the union of hydrogen and chlorine, iv., by Messrs. Mellor and Anderson. The momentary expansion in mixtures of these gases, brought about by exposure to a brilliant light, is shown to be associated with their combination and, it is suggested, is caused by some disturbance resulting from the latter.—The influence of temperature on association in benzene solution and the value of the molecular rise of boiling-point for benzene at different temperatures, by Dr. W. R. Innes. With increase of temperature, the complex molecules of phenanthrene, benzophenone, benzil, &c., produced in their solutions in benzene, become simpler up to 80°; beyond that point certain (at present) unexplained anomalies appear.—The magnetic rotation of ring compounds, camphor, limonene, carvene, pinene and some of their derivatives, by Dr. W. H. Perkin, sen. It is shown that the observed rotations of these substances agree closely with those calculated from the formulæ generally assigned to them.—Note on the constitution of certain organic nitrates, by Messrs. Marshall and Wigner. The authors express dissent from the view of Vignon and Gerin that mannitol hexanitrate contains a substituted aldehyde group, since the reducing action of the substance can be explained without such an assumption, and, moreover, the amount of nitrous acid formed on hydrolysis does not accord with the structure suggested.—Resolution of trimethylhydrindonium hydroxide into its optically active constituents, by Prof. F. S. Kipping, F.R.S. The deracemisation of this substance has been brought about by conversion into a salt of *d*-bromocamphorsulphonic acid and crystallisation from chloroform and acetic ether when the salt of the dextro-base separates first.—Resolution of methylbenzylacetic acid into its optical isomerides, by Prof. F. S. Kipping, F.R.S. Crystallisation of the quinine salt of the racemic form of this acid leads to the separation of the alkaloidal salt of the dextro-acid in the first fractions.—*d*-Methylhydrindone, by Prof. F. S. Kipping, F.R.S. This substance was obtained from the chloride of dimethylbenzylacetic acid by interaction with aluminium chloride. It rapidly racemises when heated, probably as the result of conversion into the 'enolic' form. It reacts with hydroxylamine, phenylhydrazone and semicarbazide, furnishing the various ketonic derivatives.—Optically active methylbenzylacetic acid, by Dr. Lapworth and Mr. Lenton. A repetition of the work described by Dr. Kipping in part ii.

Mineralogical Society, February 4.—Dr. Hugo Müller, president, in the chair.—Messrs. G. T. Prior and L. J. Spencer contributed a paper on the hornsilvers. They described specimens of silver haloid containing all the three halogens, chlorine, bromine and iodine, in large amount, and showed by quantitative analyses that in these holohedral cubic "iodiferous embolites" the chloride, bromide and iodide of silver could enter into isomorphous combination in very varying proportions besides the particular one found by Lasaulx in iodobromite; fusion experiments indicated that the limiting amount of silver iodide which could enter into such isomorphous combination was reached for mixtures containing the three halogens in equal atomic proportions. As the result of the investigation, the authors proposed to include all the holohedral cubic silver haloids under the common group name of hornsilver or cerargyrite, and to use the names "chlorargyrite," "bromargyrite," "embolite" and "iodiferous embolite" to indicate subspecies depending on variations in the proportions of chloride, bromide and iodide.—Mr. G. T. Prior described specimens of kilbrickenite contained in the museum of the Mining School at Camborne, Cornwall; the result of an analysis, combined with an examination of the physical characters, was to prove the identity of kilbrickenite with geocronite. He also gave the results of analyses of miersite ($4AgI.CuI$), of marshite (CuI) and of peculiar crystals of copper-pyrites simulating cubic symmetry.—Messrs. G. T. Prior and A. K. Coomára-Swámy gave an account of the mode of occurrence and characters of "serendibite," a new boro-silicate from Ceylon. This new mineral, which is of a beautiful blue colour, was discovered by Mr. Coomára-Swámy in intimate association with diopside in narrow contact zones between an acid, moonstone-bearing granulite and limestone which occur in alternating bands at Gangapiliya, twelve miles east of Kandy; no distinct crystals could be isolated, but examination of thin slices of the rock showed the mineral to be biaxial and probably triclinic; it was very pleochroic, from colourless to deep indigo-blue, and almost invariably showed a remarkable repeated twinning on as intimate a scale as the albite twinning of a plagioclastic felspar; the double-refraction is weak, but the refraction nearly as high as diopside; the hardness is about 7, the specific gravity 3·42; no cleavage was observed; it is infusible and is only slightly attacked by acids. Analysis showed the mineral to be a complex and very basic borosilicate of alumina, lime, magnesia and iron with small amounts of alkalis including lithia.—Prof. H. A. Miers exhibited three-colour collotype prints of the interference figures of crystals. These were obtained by photographing the figures through colour screens by means of a large Newton polariscope. Some of the prints reproduced with considerable success the colours and the symmetry of the original figures. The work has been executed at the Oxford University Press. He further exhibited calcite twins of a rare type from a new locality in Somersetshire, and also some crystalline gold nuggets from Klondyke.

PARIS.

Academy of Sciences, February 10.—M. Bouquet de la Grye in the chair.—On a very powerful specific treatment for malaria, by M. Armand Gautier. A detailed account of the cure of nine cases of malarial fever by the injection of sodium methylarsenate. These cases, which had all proved refractory to high doses of quinine, were, with the exception of two, immediately cured by the injection of a single dose of the methylarsenate. The remaining two cases were successfully treated with a second injection.—On the crystallisation of chromium sesquioxide, by M. Alfred Ditte. The crystallisation of chromium oxide during the calcination of a bichromate with common salt is shown to be due to the properties of sodium chlorochromate, and is in no way influenced by the solubility of the oxide in the alkaline chloride.—The determination of the exact trajectory of aërostats with respect to the soil, by M. H. Deslandres. A curve of the trajectory of the aërostat of M. Dumont on the ascent of October 19 is given and compared with the curve previously given by M. Armengaud. The two curves differ from each other considerably, the author pointing out that his own, which is deduced by a photographic method, is more likely to be accurate than that of M. Armengaud.—Radioconductors with a single contact, by M. Édouard Branly. The author has followed up some of his earlier experiments on radioconductors of one contact only, and describes two or three types which have proved very sensitive. The combination of a superficially oxidised metal with a highly polished metal has proved to be the most trustworthy,

giving the greatest variation of resistance when exposed to the Hertzian waves.—The application of thermal galvanometers to the study of electric waves, by M. L. de Broglie.—The tubes of force of the magnetic field rendered visible by means of the kathode rays, by M. H. Pellat. In an intense magnetic field, the bundle of kathode rays which escapes from a kathode in the form of a plateau corresponds exactly to the tube of magnetic force having for its base the surface of the kathode.—On the condensation of true acetylenic hydrocarbons with aldehydes: the synthesis of secondary acetylene alcohols, by MM. Ch. Moureu and H. Desmots. The sodium derivatives of the acetylene hydrocarbon react readily with aldehydes in ethereal solution at -5° C. The method is perfectly general, and ten new alcohols of this type are described.—On some iodophenols, by M. P. Brenans.—The action of crystallised arsenic acid upon pinene, by M. P. Genvresse. Arsenic acid does not act as an oxidising agent towards pinene as was expected, the principal products being either pinene possessing a different smell from the original or a terpinene, according to the proportion of arsenic acid employed.—The vascularisation of the suprarenal bodies in the dogfish, by M. Ed. Grynfeltt.—On *Menabea venenata* the roots of which furnish the *Tanghin de Menabe*, or *Sakalaves*, the poison of the ordeal, also called *Kissoumpa* or *Kimanga* in Madagascar, by M. Ed. Heckel.—On the effects of commensalism of an *Amylomyces* and of a *Micrococcus*, by M. Paul Vuillemin. The association of *Mucor rouxianus* and a *Micrococcus* feeding on sugar allows of the development of the bacterium on potato.—The discovery of a new horizon of a lacustral fossiliferous limestone interposed between the Miocenes of Ariege, by M. G. Vasseur.—On the alkaline granite of Filfila, Algiers, by M. Pierre Termier.—A new method of local anæsthesia in dentistry, by MM. L. R. Regnier and Henry Didsbury. The researches of M. d'Arsonval on the anæsthetic effects produced by currents of high frequency and high intensity have been applied with success to the purposes of practical dentistry.—An apparatus for the blind, by M. Dussaud.

GÖTTINGEN.

Royal Society of Sciences.—The *Nachrichten* (physico-mathematical section), part ii., 1902, contains the following memoirs communicated to the Society:—

July 20, 1901.—A. von Koenen: on the correlation of the North-German Lower Chalk.—J. Orth: contributions from the Göttingen Pathological Institute: (*a*) ætiology of caseous pneumonia; (*b*) tubal gravidity; (*c*) the lower jaw in so-called agnathia; (*d*) pseudo-tuberculosis; (*e*) soft cutaneous nævi; (*f*) epidermal ingrowths in cancer; (*g*) pericardial cicatrices; (*h*) renal degeneration after cœliotomy; (*i*) the testicular elastic tissue in tuberculosis and syphilis; (*j*) angiomatous changes in the liver after poisoning by coumarin.—J. Orth: histology and ætiology of pulmonary phthisis.

November 8, 1901.—W. Kaufmann: electric and magnetic deflexion of the Becquerel rays, and the apparent mass of electrons.—A. Brill: on the representation of an algebraic tortuous curve by one equation.

DIARY OF SOCIETIES.

THURSDAY, FEBRUARY 20.

ROYAL SOCIETY, at 4.30.—On Pure Cultures of a Uredine *Puccinia dispersa* (Erikss): Prof. H. M. Ward, F.R.S.—On the Physics and Physiology of Protoplasmic Streaming in Plants: Dr. A. J. Ewart.—On a Pair of Ciliated Grooves in the Brain of the Ammocœte, apparently serving to promote the Circulation of the Fluid in the Brain-Cavity: Prof. A. Dendy.—On the Interpretation of Photographic Records of the Response of Nerve obtained with the Capillary Electrometer: G. J. Burch, F.R.S.—Note on the Anomalous Dispersion of Sodium Vapour: Prof. W. H. Julius.

LINNEAN SOCIETY, at 8.—(1) On some Gasteropoda (*Limnotrochus* and *Chitra*) from Lake Tanganyika, with the Description of a New Genus; (2) On the Nyassa Vivipara and its Relationship to Neothauma: Miss L. Digby.—On the Fruit of *Melocarina bambusoides*, an Exalbuminous Grass: Dr. A. Stapf.—On a West Indian Sea Anemone, *Bunodeopsis globulifera*: Dr. J. E. Duerden.

FRIDAY, FEBRUARY 21.

ROYAL INSTITUTION, at 9.—Musical and Talking Electric Arcs: W. Duddell.

INSTITUTION OF MECHANICAL ENGINEERS, at 8.—Annual General Meeting. Followed by discussion on Modern Machine Methods, with Reply by the Author, H. L. F. Orcutt, and, time permitting, Fencing of Steam- and Gas-Engines: H. D. Marshall.—Fencing or Guarding Machinery used in Textile Factories: S. R. Platt.—Protection of Lift-Shafts, and Safety Devices in connection with Lift-Doors and Controlling Gear: H. C. Walker.—Guarding Machine Tools: W. H. Johnson.

GEOLOGICAL SOCIETY, at 3.—Annual General Meeting.

EPIDEMIOLOGICAL SOCIETY, at 8.30.

SATURDAY, FEBRUARY 22.

ROYAL INSTITUTION, at 3.—Some Electrical Developments: Lord Rayleigh, F.R.S.

ESSEX FIELD CLUB (at Essex Museum of Natural History, Stratford), at 6.30.—George Edwards, the Stratford Naturalist: John Avery.—Protective Resemblance, Warning Colours and Mimicry, some New Illustrations of well-known Principles: Prof. E. B. Poulton, F.R.S.

MONDAY, FEBRUARY 24.

ROYAL GEOGRAPHICAL SOCIETY, at 8.30.—The Voyage of the Antarctic Ship *Discovery*: The President; G. Murray, F.R.S.; and Dr. H. R. Mill.

SOCIETY OF ARTS, at 8.—Personal Jewellery from Prehistoric Times: Cyril Davenport.

IMPERIAL INSTITUTE, at 8.30.—British Columbia: Hon. J. H. Turner.

INSTITUTE OF ACTUARIES, at 5.30.—Some Notes on the Net Premium Method of Valuation, as affected by recent Tendencies and Developments: S. G. Warner.

TUESDAY, FEBRUARY 25.

ROYAL INSTITUTION, at 3.—The Temperature of the Atmosphere: W. N. Shaw, F.R.S.

INSTITUTION OF CIVIL ENGINEERS, at 8.—*Paper to be further discussed*: Electrical Traction on Railways: W. M. Mordey and B. M. Jenkin.

SOCIETY FOR THE PROMOTION OF HELLENIC STUDIES, at 5.—Humour in Greek Art: A. H. Smith.

WEDNESDAY, FEBRUARY 26.

SOCIETY OF ARTS, at 8.—Recent Inventions in Weaving Machinery: Prof. Roberts Beaumont.

GEOLOGICAL SOCIETY, at 8.—On some Gaps in the Lias: E. A. Walford.—The Origin of the River-System of South Wales and its Connection with that of the Severn and Thames: A. Strahan.

THURSDAY, FEBRUARY 27.

ROYAL SOCIETY, at 4.30.

SOCIETY OF ARTS at 4.30.—The Industrial Development of India Nilkanth B. Wagle.

INSTITUTION OF ELECTRICAL ENGINEERS, at 8.—Electric Shock and Legislation thereon: Major-General C. E. Webber, C.B., R.E.—Electric Shocks: F. B. Aspinall.—Electric Shocks at 500 volts (illustrated by a Demonstration of 500 volts): A. P. Trotter.

FRIDAY, FEBRUARY 28.

ROYAL INSTITUTION, at 9.—Gold Mining in Klondyke: Prof. H. A. Miers, F.R.S.

INSTITUTION OF CIVIL ENGINEERS, at 8.—Indicating High-Speed Steam-Engines: A. M. Arter.

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THURSDAY, FEBRUARY 27, 1902.

BRITISH GEOGRAPHY.

Britain and the British Seas. By H. J. Mackinder, M.A., Reader in Geography in the University of Oxford. Pp. xvi + 378. (London: William Heinemann, 1902.)

THIS important contribution to geographical literature is, we believe, the first effort to present a complete geographical description of the British Isles in accordance with modern views, complete, however, rather in comprehensiveness of scope than in exhaustiveness of detail. The work strikes us as literature—clothing in dignified and continuous form the theories and conclusions of many workers—rather than science, which in the existing state of geographical knowledge demands more critical treatment of controversial matters and more direct contact with original data. The author excels in broad generalisations, and he has a happy knack of setting essential facts in striking lights, so that they are forced on the attention of the reader and remain fixed in his memory. It is impossible, of course, that any one man could be an independent authority on all the subjects which have to be dealt with in a geographical description; but Mr. Mackinder has got up his case so thoroughly that it is only by the smoother running of his chariot wheels where he enters on the domain of human, and especially of historical, affairs that we are led to suspect which are his most familiar studies.

A striking merit in the arrangement of the book, and it is a great one, is that no doubt can arise as to its purpose and plan. The development of the argument is preceded by an opening statement and clenched by a formal array of numbered paragraphs setting forth what is claimed as having been established. Unlike many books which are geographical in intention, this one is consistent throughout, tracing an unbroken chain of causation from the earliest hypothesis as to the existence of ancient land in the geological past to the latest forecast of thought in the political future. The chain is not equally strong in all its parts, and its extremities pass into regions of gloom which some faith is required to believe illumined.

The first chapter treats of the position of the British Islands (which we are glad to see gathered under the one word Britain), showing how in classical times they were at the end of the habitable world, with only ocean and ice beyond, while now they lie in the very centre. Mr. Mackinder speaks of the ice drift in the East Greenland current as "the physical boundary of mediæval Europe"; yet there is some evidence to show that the western voyages of the Norsemen met but slight obstruction from the ice, and the vanished settlements of East Greenland point to a comparatively recent increase in the severity of the climate. That the trade-winds blow over the Sahara we should not like to affirm, though Mr. Mackinder is doubtless correct in taking the southern boundary of the mediæval world of Europe as the Trades and the desert. But when the reign of terror of the half-known—cold and heat and the vacant spaces of ocean—was shattered by the voyagers from Iberia, Britain swung into the centre of the land hemisphere:—

"Seen thus in relation to earlier and to later history, Britain is possessed of two geographical qualities, complementary rather than antagonistic: insularity and universality."

The nature of the insularity is investigated in a chapter on the British seas, contrasting the Ocean with the Narrow Seas towards Teutonic Europe and the Narrower Seas towards France; and the remarkable coincidence that the narrowest channel, which separates Kent from the continent, lies opposite the terminus of the great Teutonic-Romance linguistic frontier of Europe is treated with a masterly completeness.

The movement of the waters, tidal and circulatory, receives a chapter to itself, and then on p. 46 the serious part of the book begins, and the general reader will meet with his first check, for he must enter on a hundred pages of fairly stiff geology. This is not the geology of the text-books; formations are scarcely referred to, and there is absolutely nothing of palæontology. It is a restatement, and in some particulars an extension, of the history of the rifted crust-blocks of Suess and the system of coastal-plain formation and river-development with which the name of W. M. Davis is usually associated. The theories are boldly and skilfully employed, and in their light the building of the British Isles stands forth with startling clearness; the author might have seen it all. We question whether any geologist intimately acquainted with the details and the infinite uncertainties of one department of his science would have dared to compress the history of the past into the few clear-cut episodes which are here presented in a manner which wins our admiration even if it fails to gain our entire confidence. We may quote part of the author's summary, bearing in mind that a much fuller statement is given in the pages:—

". . . . The fringe of headlands along the west coast of Scotland, and the lie of Glenmore and the Rift Valley, betoken a south-westerly rock-graining, to be interpreted as the wreck of a Caledonian mountain range, which once crossed the site of the North Sea.

"But the existing hills have not been shaped from the Caledonian peaks by uninterrupted erosion. The general equivalence of the higher summits, and the transverse, southerly trend of the consequent valleys where they breach the ridges, can only be explained by the interpolation of an epoch during which the mountains were reduced to a basal plain. Thence followed a fresh cycle of denudation when the plain was raised to a grained plateau spreading back from the British Uplands towards Iceland and Greenland.

"By what process the plateau of Atlantis collapsed and the uplands of its south-eastward face were transferred to developing Europe, may be imagined from the form of the ocean bed. Two abysmal pits, Atlantic and Arctic, gradually encroached upon the land until they merged across it, and the divide between them became the submarine isthmus known as the Scoto-Icelandic Rise. The southward belt of median uplands in Britain—Highland, Central and Cambrian—is in prolongation of this rise, and no doubt due to the same terrestrial stresses.

"Britain was differentiated from the rest of the slope of Atlantis by the formation of proto-Britain in advance of the Caledonian shore line. Against the resistance of this salient block the Hercynian pressures crumpled the strata into northward and westward folds, and these,

together with the earlier south-westward features, have determined the triangular outline of Britain.

"By their intersection the Hercynian axes also shaped the coal-basins of Great Britain; but Ireland, under the lee of proto-Britain, suffered less disturbance and has therefore been stripped of most of its coal, which was thus unsheltered from denudation.

"The posthumous Hercynian uplift which raised the Wealden fold, produced an organic connection between the Kentish promontory and the Rhine-Seine divide, and the English plain of softer rocks is, therefore, a segment of the coastal plain of Atlantis, preserved and brought into European relations by events of late geological date."

Here we have a kinematograph picture, with scarcely any flickering. Something like this has most probably happened; but few readers will, we fear, be in a position to understand that the events referred to can only be felt out in dimmest outline by very uncertain inferential methods, which in various hands have given different results. Mr. Mackinder goes on to connect the process of geotectonic history with human history, but the connection strikes us as in large part metaphysical if not fanciful. Unquestionably the relief of the land, and the climate—which, by the way, is treated with charming simplicity and fidelity to verifiable facts—exercise a powerful directive influence on the distribution of life and on the course of human history, and undoubtedly the land owes its relief to the processes of geological history; but we contend that no matter what the precise course of that history may have been, the surface-forms once produced, no matter how, would have exercised the same functions in controlling distribution. Whether a mountain is folded up by the puckering of a plain, or cut out by the carving of surrounding valleys, or poured forth as lava, or piled up as ashes, if it has assumed a given form and is covered by a particular soil its action upon life and man will be identical.

Our argument is that the same final result might be the outcome of any one of a number of causes; and that the latest Earth-movements, though slight, are more potent in their geographical aspect than early movements of far greater magnitude. In fact, we believe that actual landforms, not the processes of their formation, are the real elements of geography.

Such a book as this ought not to be criticised in detail, but judged broadly according to its plan, its scope and its methods. Still, we cannot help noticing some inequalities of treatment which exercise a warping influence on the framework of the argument. It is, from the geographer's point of view, a trifle of no importance that the Glacial and post-Glacial periods are classed as Tertiary, and it may be that the author is right in saying that Ramsay's views as to the origin of lakes by ice-action are now gaining ground—though we should like to hear him propound this theorem at a meeting of the Geological Society—but he is certainly wrong in dealing so briefly with the Glacial episode as a whole. A geographer could not, we should have thought, consider the parts of Britain north of the Thames and Bristol Channel without recognising how profoundly the whole face of Nature has been modified by the power of ice. The map of the solid geology gives but a poor idea of the actual surface of the land, the contours of which are due over large areas to boulder clay alone; and the courses of many rivers have suffered revolutions in the Ice-age which must entirely mask the consequences, the subsequences, nay even the obsequences of the secular advance of the "geographical cycle." We feel sure that even though Mr. Mackinder's geomorphology may be criticised and possibly confuted in parts, the latter and more purely geographical part of his work will stand unshaken.

This latter part includes a chapter on racial geography and another on historical geography which are models of clear and brilliant exposition. They will not, perhaps, give pleasure to the devotees of Celticism, who may be inclined to demand proofs for a classification including "the catholic Irishman essentially a pre-Celt . . . , the Highlander pre-Celtic and mercurial . . . , the Welshman with a strong pre-Celtic infusion." The different regions of the country are considered under the heads of Metropolitan England, Industrial England, Scotland and Ireland, showing how the dominant facts of relief, structure and climate control the life of the people, the routes along which they travel and the sites in which they settle. Here there is nothing of the gazetteer or the guide-book; no attempt is made to enumerate all important towns, and throughout the references to scenery are surprisingly scanty; but the reader feels that he is being initiated into some of the secret springs of history. Two chapters follow impressing these views still more strongly; they treat of strategic and economic geography, and the latter in particular shows much care and completeness. It is curious, however, to notice that while the power of the tides, which are still unharnessed, is spoken of in almost poetical terms as a possible substitute for coal, the water power of the land, better understood and more utilised as it already is, has hardly any attention directed to it. Yet even now we find water power successfully competing with coal in the supply of electrical energy for extensive manufactures, and its vast potentialities are not unknown to practical men. A short chapter on Imperial Britain illustrates some of the lessons which the geographer may teach, or at least offer to teach, the politician; and a summary and conclusion recapitulate the argument.

There is, in our opinion, too much hypothesis in the book, and the grounds for many of the conclusions are inadequately stated. Rival interpretations are not set one against the other, and the reader coming fresh to the subject is apt to form an exaggerated opinion of the certainty of some historical processes, both geological and human. But, on the other hand, we have here an attempt to show how the worlds of Nature and Man may very justly be conceived as knit together, and it is extremely probable that such a book, written with more boldness than most scientific men could display, will bring home some aspects of scientific thought to minds shut against ordinary and clumsier exposition. The book is eminently deserving of study, and it is sure to suggest many new and valuable ideas both to novices and experts.

The numerous illustrations are restricted to maps and diagrams, and we have never seen sketch-maps used to better purpose, although a few betray in their weak outlines a draughtsman not yet fully alive to the precautions required in drawing for photographic reduction.

THE BOOK OF THE DEAD.

The Book of the Dead: an English Translation of the Chapters, Hymns, &c., of the Theban Recension, with Introduction, Notes, &c., and with Four Hundred and Twenty Vignettes. By E. A. Wallis Budge, M.A. Litt.D., D.Lit. In three volumes. Pp. xcvi + viii + iii + 702. Vols. vi.–viii. of the series "Books on Egypt and Chaldæa." (London: Kegan Paul and Co., Ltd., 1901.)

READERS of NATURE will remember that nearly three years ago we noticed the appearance of a work, published by the trustees of the British Museum, in which facsimiles were given of the Egyptian papyri of Hunefer, Ȧnhai, Kerāsher and Netchemet, together with the text of the papyrus of Nu, the whole work being edited and annotated or translated by Dr. Wallis Budge, the keeper of our national collection of Oriental antiquities. As we pointed out at the time, this monumental work completed the series of facsimiles of papyri of the "Book of the Dead," which the trustees of the Museum have published at intervals during the last eighteen years, and by its appearance furnished scholars with a remarkable series of papyri of all periods for the study of the funereal literature of the ancient Egyptians. The great amount of new material published in this series of volumes rendered still more apparent the want of a complete edition of the text of the "Book of the Dead," which has been increasingly felt since the appearance in 1886 of M. Naville's "Das Todtenbuch der Ægypter," in which were given the various chapters from the different papyri then available.

The want was supplied by Dr. Budge, who, under the title "Chapters of Coming Forth by Day," published a complete edition of the text, based upon all known papyri, together with a translation and a full vocabulary to the hieroglyphic texts. This bulky work in three volumes appealed in the main to scholars, while its price placed it beyond the reach of many whose interest in the "Book of the Dead" stopped short of the acquisition of its complete hieroglyphic text. It was in answer to numerous requests from this latter class of readers, as we learn from the preface to the volumes before us, that the publishers decided to include Dr. Budge's English translation in their series of little "Books on Egypt and Chaldæa." The books under review, however, contain no mere reprint of a portion of the former work. Careful revision, based on a comparison of the original documents, constitutes the translation a new edition of the English rendering; and while from the introduction the general reader may gain a knowledge of the history, object and contents of the "Book of the Dead," he need not be puzzled by obscure references or phrases in the translation if he consults the many explanatory notes which have been added to this edition. We shall in the main confine ourselves to the new material thus presented, and shall refer in some detail to the remarkable series of vignettes here published for the first time; before doing so, however, it will be necessary to sketch briefly the nature of the religious texts which are here translated.

The title "Book of the Dead" is now almost a household word, and it is never likely to be changed either for the Egyptian title "Chapters of Coming Forth by Day," or for any conventional description of its contents. That it is unsatisfactory Dr. Budge admits, for the "Book of the Dead" is not a book in the strict sense, that is to say, it is not a fixed composition the different copies of which vary but slightly. But the title is short, it is sanctioned by the authority of Champollion and Lepsius, and the texts so described certainly concern the dead; moreover, it is far preferable to the titles "Ritual of the Dead" and "Funeral Ritual," which have been suggested as substitutes. The great body of Egyptian religious texts which bear this title have a long and varied history; with their origin buried in the remote past, they grew by accretion throughout the whole life of the Egyptian nation, and their contents reflect the beliefs and opinions of many different and conflicting schools of thought. But, as Dr. Budge points out, every chapter or section that has yet been recovered has a link which connects it with the rest; however barbarous or however exalted may be the character of the beliefs a chapter embodies, it shares a common object with the others—that of benefiting in some way the deceased. And it is this common object which constitutes the claim of the "Book of the Dead" to be the great national religious composition of ancient Egypt. In what way its chapters were to benefit the deceased may best be described in Dr. Budge's own summary:—

> "They were intended to give him the power to have and to enjoy life everlasting, to give him everything he required in the life beyond the grave, to ensure his victory over his foes, to procure for him the power of going whithersoever he pleased and when and how he pleased, to preserve the mummy intact, and finally to enable his soul to enter into the bark of Rā or into whatever abode of the blessed had been conceived of by him."

The recently discovered graves of some of the indigenous inhabitants of Egypt show that two distinct methods of burial were practised at that early period, and probably by two distinct peoples. By the one the dead were partially burnt, and afterwards the skull and bones were placed in a shallow pit; by the other the body was buried either whole or after it had been dismembered. Both peoples oriented the dead in the same direction and both made offerings to the dead. It is clear, therefore, that both peoples had a clear perception of a future life, while the traces of bitumen discovered by Dr. Fouquet upon some of the buried bodies suggest that these early inhabitants of Egypt, like their later descendants, believed that the welfare of the deceased depended upon the preservation of their earthly remains. Although no inscriptions have been found in these early graves, there is much that lends colour to Dr. Budge's suggestion that the origin of the "Book of the Dead" may be traced to the prayers and formulæ recited during burial at this early period in order to preserve the dead body from the attacks of wild animals and from decay. The earliest written version of the "Book of the Dead" occurs upon the walls of the chambers and passages in the pyramids of the kings of the fifth and sixth dynasties at Saḳḳâra, and it does not, therefore, date from an earlier period than B.C. 3500; but the mistakes and misunderstandings of the scribes who engraved these texts prove that many of the formulæ were even then unintelligible

by reason of their antiquity; moreover, the beasts and creatures, which the prayers and spells were intended to frighten away from the dead man, belong to the period when forests clothed the banks of the Nile in Egypt and river monsters of all kinds abounded which are now only to be found on the upper reaches of the Blue Nile and near the Great Lakes.

In his introduction, Dr. Budge has brought together some exceedingly interesting evidence that parts of the "Book of the Dead" were in general use even before the period of the kings of the first dynasty; but what concerns us here is, not the early history of the book, but the traces which its early history has left upon it, and which have been retained even in its most perfect and complete form, the so-called "Theban version," which is found written upon papyri in tombs of the eighteenth, nineteenth and twentieth dynasties. The Egyptian was conservative to the backbone, and to this conservatism the anthropologist and the scientific student of religion are much indebted; for as he advanced in his religious beliefs and conceptions, he did not discard all traces of his earlier and more primitive state, but along with the profession of his more spiritual faith he jealously clung to and retained the earlier spells and formulæ which had long ceased to apply to his own condition of life. It is thus possible in the "Book of the Dead" to trace the semi-barbarous North-African element contending with more moral and spiritual beliefs, the rise of which Dr. Budge traces to the presence of some Proto-Asiatic element in the composition of the Egyptian race. The space at our disposal does not admit of our treating this fascinating subject at greater length, and for a more detailed discussion we must refer the reader to Dr. Budge's introduction.

We have already made a brief reference to one of the most striking characteristics of this latest edition of the "Book of the Dead"—the beautiful series of outline blocks with which the chapters are illustrated. The ancient Egyptian scribes and artists used to add to the separate chapters or sections of the work vignettes, or pictures, intended to illustrate their general contents and also to have in themselves a magical effect upon the destinies of the deceased; and these pictures are often of considerable assistance in the interpretation of the texts to which they refer. Dr. Budge has selected the vignettes from the best papyri, and where the designs vary in different papyri he has given more than one version; as interesting examples of varying treatment we may refer to the three vignettes illustrating the "Weighing of the Heart" (p. 31 *f.*), the numerous illustrations to chapter xvii. and the curious variant to the vignettes of chapter xxxvi. This last chapter ensures the driving away of the insect called *Āpshait*, which Dr. Budge identifies with

"the beetle which is often found crushed between the bandages of poorly made mummies or even inside the body itself, where it has forced its way in search of food."

Thus, in most vignettes to this chapter the deceased is represented spearing a beetle, as in those illustrated on p. 161; but in the vignette on p. 162 the deceased is portrayed spearing a pig and not a beetle, which the translator ingeniously explains as due to the scribe having confused the proper name *Āpshait* with *shaā*, the word for "pig." The vignettes throughout the volume have been faithfully drawn from the originals in bold, clear outline, and, apart from the light they throw upon the text, they form in themselves a beautiful series of examples of Egyptian design and draughtsmanship.

In conclusion, we may say that we heartily endorse the remarks which are made in the preface with regard to the fashion that has grown up among certain writers on Egyptology during the last few years, who decry the "Book of the Dead" and announce as a great discovery that parts of its text are corrupt. But, as Dr. Budge remarks, this fact has been well known to Egyptologists for the last fifty years, and is, moreover, a characteristic shared by every great national religious composition which is handed down first by oral tradition and secondly by copies which are multiplied by professional scribes.

"The more the 'Book of the Dead' is read and examined," he adds, "the better chance there is of its difficult allusions being explained and its dark passages made clear, and this much-to-be-desired result can only be brought about by the study, and not by the condemnation, of its texts."

To this end no other scholar has contributed so much as Dr. Budge himself, and his latest efforts, embodied in the volumes before us, will place a rich store of material within the reach of the humblest worker in the great field of the comparative study of religions.

FOSSIL FISHES IN THE BRITISH MUSEUM.

Catalogue of Fossil Fishes in the British Museum (Natural History). Part iv. By Arthur Smith Woodward, LL.D., F.R.S., F.G.S. Pp. xxxviii + 636, 22 figures, 16 plates. (London: Printed by order of the Trustees, 1901.)

THE fourth volume of this great work, which has just appeared after an interval of six years since the publication of the third volume, completes the account of the unrivalled collection of fossil fishes preserved in the national museum, to which the author has devoted so much attention during the twenty years which have preceded his appointment to the post of keeper of the geological department, on the retirement of Dr. Henry Woodward. The issue of this volume, dealing entirely with the Teleosts, was eagerly awaited, not only by palæontologists, but also by all students of fishes, as great hopes were entertained that a revised arrangement of the bony fishes, the preponderating element in the recent fauna, would result in very considerable progress in our understanding of the inter-relations of the components of this difficult group.

If the feeling of joy be mixed with some disappointment at so many problems of classification remaining unsolved, the fault rests entirely with the nature of the material with which Dr. Woodward has had to deal. Those who merely glance over the beautiful series of fish-remains exhibited in the gallery at South Kensington are apt to carry away too sanguine an impression of the osteological information which is to be obtained from their study. It is a fact that, on some very essential points, fossil remains, however numerous and well preserved they may appear, still fail to afford the information which is most wanted. As an example we would allude

to the regrettable fact that the author has been obliged to abandon the use of a very important character in the definition of the higher groups, viz. the presence or absence of the mesocoracoid or "precoracoid" arch, the presence of which in the Isospondyli as understood by Cope had been duly emphasised in the diagnosis of this suborder at the end of the preceding volume. The Isospondyli are now made to include the Haplomi, an innovation with which the reviewer is unable to agree for the reason that the study of recent fishes proves their separation to be absolutely necessary. Even where the character of the "precoracoid process" is appealed to for the definition of families, error has crept in, at least in the case of the Gonorhynchidæ, which are stated to be devoid of it, and hence are unjustifiably regarded as "only slightly modified Scopelids." Other points in the identification of the elements of the pectoral arch seem in need of revision, as in the Thrissopater figured on plate vii., where the bone named "postclavicle" either represents the supraclavicle or overlies the latter and the clavicle, in which latter case it does not, as I believe, answer to the definition of the Elopidæ, and in the restoration of *Eurypholis boissieri*, p. 206, where the basalia of the pectoral fin are represented as attached to a bone termed "postclavicle." In the definition of the Apodes, "pectoral fin with more than five basalia" is true of Anguilla, but does not apply to Conger and other genera.

It is clearly often impossible to assign extinct fish-remains to their systematic position with that rigid precision which may be attempted in the case of living forms. Dr. Woodward, as he tells us in the introduction, has therefore deemed it advisable to adopt a broad conception of families and genera more in accordance with that of Dr. Günther than with that of later writers. But his classification, on the whole, is greatly ahead of that followed in Zittel's manual and in the text-books published in this country. He has amply availed himself of the reforms introduced by Cope and by Sagemehl. The arrangement of the great group of Acanthopterygians is still the most unsatisfactory, the definition of its subdivisions being of a very provisional nature and lacking in precision; groups like the Beryciformes, Chætodontiformes and Blenniiformes are certainly quite artificial, and the new sense in which these terms are used must be regarded as a retrograde step. Some explanation might have been given by the author of the reasons that have induced him to place the Blochiidæ among the Blenniiformes rather than among the Scombriformes.

The fossil forms dealt with under the Isospondyli offer a highly interesting and suggestive gradation from the later Ganoids to the earlier Acanthopterygians, such as the Berycidæ, so abundant in Cretaceous formations, but we are unfortunately still without a clue to the derivation of the eels proper, or Apodes, degenerate fishes which are traced back to the Chalk. Among these, Urenchelys, from the Chalk of Mount Lebanon, is shown to differ from existing genera of the same family in having a small caudal fin supported by expanded hypurals, thus showing the "diphycercal" condition which prevails at the present time to have been derived from a "homocercal." The Percesocine genus Cobitopsis settles once for all the vexed question of the systematic position of our sand-launce, Ammodytes, as it has retained the abdominal pelvic fins which have entirely disappeared in the existing genus; Ammodytes must hence be removed from the Ophidiid Anacanthines and placed near the Scombresocids or gar-pike and allies.

The publication of the "British Museum Catalogue of Fossil Fishes" marks a great advance in ichthyology, and we heartily congratulate Dr. Smith Woodward on its completion. It is announced in the preface that the author proposes to prepare, in the course of the present year, a supplement giving a list of additional important genera discovered and published since the earlier volumes were issued, the first dating as far back as 1889; also a stratigraphical table showing the appearance in time of families and genera of fossil fishes, together with a general index to the four volumes.

A last word as to the illustrations. The plates, as well as the outline figures in the text, are excellent, both from the point of view of artistic finish and scientific accuracy, and do the greatest credit to the artist, Miss G. M. Woodward. The intercalation of a collotype plate (xvii.) is, however, to be regretted, as not in keeping with the style of the other illustrations and quite superfluous, the figures having already appeared elsewhere, although no allusion to this is made in the accompanying explanation.

G. A. B.

OUR BOOK SHELF.

Tales of a Dying Race. By Alfred A. Grace. Pp. x+250. (London: Chatto and Windus, 1901.)

THE title of this little book is somewhat misleading. Out of eight-and-twenty tales, only four are, properly speaking, Maori tales. The rest are stories of the contact between the Maories and the white settlers, traders and missionaries. Even the four Maori tales are retold in *pakeha* fashion, until there is little of the Maori left in them beyond the skeleton. The majority have already appeared in antipodean periodicals. They are all charmingly told, and, illustrating as they do many sides of the Maori character and the romance of earlier days of the colony, they form a worthy tribute to the noblest of savages, and cannot fail to rouse vivid feelings of regret that the race is doomed to extinction. Mr. Grace writes of the people and their surroundings with keen sympathy, the full secret of which is not disclosed until the last story, in which he relates an adventure of his early life as a missionary's son, when his mother and her children were rescued from an impending and horrible death by the unflinching courage and fidelity of a native chief. He has done well to preserve the narrative, as well as the other contents of this entertaining book, in a permanent form; but he himself would hardly claim scientific value for the collection.

Lehrbuch der Differentialgleichungen. Von Dr. H. Liebmann. Pp. vi + 226. (Leipzig: Veit and Co., 1901.)

THIS interesting and well-written book shows that the ideas of Sophus Lie are at last bearing fruit, even in elementary text-books. There are three chapters dealing respectively with ordinary differential equations of the first order, with similar equations of higher order and systems of such equations, and with partial differential equations of the first order with two independent variables. Besides this, there is an introductory chapter dealing mainly with existence-theorems, and a concluding one on partial differential equations of the second order.

The examples are numerous, and admit of geometrical interpretation; many of them illustrate the theory of tangential transformations, which, happily, receives a good deal of attention. The articles on existence-theorems appear to be sound, so far as they go, and are unusually readable. Altogether, Dr. Liebmann's book may be recommended as a useful introduction to the modern treatment of the vast subject with which he deals. M.

The Theory of Equations: with an Introduction to the Theory of Binary Algebraic Forms. By W. S. Burnside, M.A., D.Sc., and A. W. Panton, M.A., D.Sc. Fourth edition. 2 vols. Pp. xiv + 286 and xii + 292. (Dublin: Hodges, Figgis and Co., Ltd.; London: Longmans, Green and Co., 1899, 1901.)

IN this new edition of a well-known and popular treatise the principal change is the addition of a chapter on the theory of substitutions and groups. Following the methods of Serret, Jordan and Netto, the authors give just so much of the elementary theory of substitution-groups as to enable them to prove the fundamental property of the Galoisian resolvent of an equation, and to demonstrate that the general equation of any degree higher than the fourth cannot be solved by an algebraic formula. It is strange that no reference is given to the work of Kronecker and others on equations which do admit of algebraic solution.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

Note on Electric Charging and Discharging at a Distance.

A NUMBER of experiments, which I began in 1888, continued in 1894 and again in 1896, have been waiting for publication until the completion of certain others that I have been hoping to find time to carry out. As, however, the results are somewhat akin to those on the discharge of insulated bodies that are of great interest at the present time, it may be worth while not longer to delay publishing a preliminary note on a few of them.

The interest of the experiments lies partly in the fact that I was not merely able to *discharge* an electroscope by means of various bodies, hot and cold, placed within distances from it varying between 1 cm. and 300 cm., but that I was also able to *charge* the electroscope by the same means. The special interest, however, arises from *cold* bodies, viz. cotton wool dipped in ether, methylated spirit, or dilute sulphuric acid, being different, so far as I am aware, from any that have hitherto been employed for discharging or charging an electroscope at a distance.

A gold-leaf electroscope was employed, its outer case properly screened with strips of tinfoil, and the knob replaced with a metal pot to increase its capacity. A charge sufficient to make the leaves diverge by rather more than a right angle was generally given, so as to render the collapse easy to see. In every case the sign of the charge was tested before it was noted.

I.—*Discharging an Electroscope at Short Distances by means of a Candle Flame.*—With an insulated candle flame at 15 cm. distance, the leaves collapsed in forty seconds, whether they were charged positively or negatively. At 40 cm. between the two, the positive charge leaked away more slowly than the negative. With 42 cm. distance, the leakage was very slow for both, and at 48 cm. there was none.

When the candle was earthed, by having a wire sticking into the wick, the discharge was quicker than when it was insulated, but not if the wire dipped into the melted wax. The flame of a match had no less power, and an electric arc no more power, than an uninsulated candle flame placed at the same distance.

II.—*Discharging an Electroscope at Long Distances by means of an Insulated Candle.*—The candle and the electroscope were next placed 150 cm. apart and a *negative* charge given to the electroscope. Result—no leakage. A glass rod was then rubbed, brought up to the candle on the side *remote* from the electroscope, and then withdrawn. When this had been done several times, the leaves began to collapse, and collapsed in jerks, each time the rod was excited, brought near the candle and withdrawn. The collapse appeared to take place at the withdrawal of the rod. The same experiment was performed with distances varying up to 200 cm. between the candle and electroscope, and the numbers of withdrawals and re-excitations of the glass rod that were needed before the leaves began to collapse were noted. It varied from 1, with a distance of 125 cm. between candle and electroscope, to 14, with a distance of 203 cm. Thus the number of excitations increased very rapidly with the distance. The same results were obtained by charging the electroscope positively and bringing rubbed sealing-wax up to the candle. The further the distance of the two apart, the longer was it before the leaves began to collapse and the slower was the collapse when it began.

III.—*Charging an Electroscope at Long Distances by means of an Insulated Candle.*—All the experiments in II. were repeated, but the electroscope and the candle were now charged with the *same* sign. The number of withdrawals before the leaves began to move was much the same as before, but now the leaves diverged more widely, whether both electroscope and candle were charged positively or negatively. The electroscope was then left uncharged, and the charge rod was brought up to the candle as before. The leaves then diverged, and were found to have a charge of the same sign as that of the rod. Thus a charged electroscope placed at a distance up to 200 cm. from an insulated candle can be discharged by repeatedly bringing a charge of the *opposite* sign near the candle, on the side remote from the electroscope, and, similarly, an uncharged electroscope can be charged with a candle and rod placed at distances up to 200 cm. from the electroscope.

IV.—*The same Experiments with an Earthed Candle Flame.*—None of the results in III. are obtained if the candle is earthed.

V.—*Discharging an Electroscope by means of a Red Hot Platinum Wire.*—I., II., III. and IV. were repeated with the candle replaced by a platinum wire kept red hot by a current from two Grove's cells, which were placed on a cake of sealing-wax standing on four cubes of paraffin wax when the cells were required to be insulated. The results were practically the same as with the candle flame, except that the platinum wire, when earthed, discharged a negatively charged electroscope, but not one positively charged. Also when it was insulated, it discharged the electroscope at as great a distance, in one case, as 300 cm. from it.

Since writing the preceding, I find that some experiments on discharging, and discharging by means of *hot* bodies placed at *short* distances from the electroscope, were described by Prof. Worthington at the meeting of the British Association in 1889.

VI.—*To Restore to Platinum Wire the Power to Discharge when it has lost it by being kept White Hot for many hours.*—Prof. Schuster first observed, I believe, that glowing platinum wire ceased to discharge electrified bodies near it after it had been kept white hot for some time. He attributed its discharging power to occluded gases and the loss to these having all been expelled. To see if the power could be restored to the wire by placing any substance on it, I first put a drop of oil on some wire that had lost its power, but with no effect. A grain of sugar was equally ineffectual, &c., but either salt or common washing soda was, I found, instantly efficacious. It seems possible, therefore, that it is some trace of a salt of sodium or other metal on an ordinary platinum wire that either enables, or assists, the hot wire to discharge, and that the white heat chemically cleans this off. I intend, however, to make further experiments on this point.

VII.—*Charging and Discharging an Electroscope by means of Cotton Wool dipped in Ether, Methylated Spirit, or Dilute Sulphuric Acid—the whole Insulated.*—II., III. and IV. were next tried, when the candle flame was replaced with an insulated saucer of cotton wool, saturated in turns with ether, methylated spirit and dilute sulphuric acid placed at a distance from the electroscope. Each was found to act just as well as the candle flame and in the same way. None would act when earthed, and carbon dust—dry—was quite ineffectual in both cases.

Many other experiments were tried, but the preceding are sufficient to show the nature of the phenomena observed.

HERTHA AYRTON.

The Origin of the Scale of Fahrenheit's Thermometer.

YOUR issue of February 13 contains, on p. 348, a note on the above subject, in which it is stated that Fahrenheit based his scale upon a scale previously adopted by Newton, Newton's scale having its zero at freezing point and the temperature of the human body marked as 12 degrees. Fahrenheit (says Sir Samuel Wilks) found Newton's divisions too large. He therefore divided them by two. Next he altered his zero to the temperature produced by a mixture of ice and salt. Later on he again divided each degree into four parts, giving the scale which is now in use. This explanation is substantially that which is given in the "Encyclopædia Britannica."

It is evident that the origin of the Fahrenheit scale is a matter of some speculation. A recent work, the "Evolution of the Thermometer," by Mr. H. C. Bolton (reviewed in NATURE of May 9, 1901), states that Fahrenheit's selection of a scale was unfortunate, and did not appear to have been based on anything.

It seems very unlikely that Fahrenheit, who was an accomplished man of science and experimenter, and whose thermometers were acknowledged to be a great advance on others existing at the time, should have based his scale on nothing at all.

An examination of the main features of Fahrenheit's work upon thermometers gives, I think, the key to the origin of the scale, and shows that he based it upon a very sound and scientific foundation. In discussing this question, one must have a regard for the state of the knowledge of kindred matters at the beginning of the eighteenth century, and consider how the problem would be likely to present itself to Fahrenheit.

Reference is made in the note to a paper in the *Philosophical Transactions* for 1701, supposed to have been written by Newton. In this paper, which is written in Latin, is described a scale of degrees of temperature (Scala graduum Caloris) from the freezing point of water to the melting point of gold, but it does not appear that this scale was intended to be actually applied to a thermometer. It seems only to be intended as a convenient scale of reference for comparing temperatures covering a very wide range. The zero or starting point is the freezing point of water. The external temperature of the human body is taken as the second point from which the scale is derived. The range of temperature between these two points is divided into twelve parts. The freezing point is, therefore, called 0, and the body temperature 12. The scale is continued upwards, and it was found that the temperature of water boiling violently corresponded to 34 degrees. Many other degrees are noted as indicating the melting points of metals, &c.

The paper continues with a description of a thermometer, the liquid element of which is linseed oil. The actual scale of the thermometer, however, was not that described above, but was determined as follows:—

The thermometer was placed in melting snow. The space filled by the oil in the bulb and the stem together was taken as occupying 10,000 parts. The same oil, when expanded by the heat of the human body, occupied a space of 10,256 parts, and by the heat of boiling water 10,725 parts. Thus, on this thermometer, if the freezing point was marked 0, body temperature was 256 and boiling water 725. It was by means of this thermometer that the temperatures were obtained from which the "Scala graduum Caloris" was computed.

Fahrenheit is credited with having been the first to use mercury in the thermometer. He also discovered how to produce a temperature much below the freezing point of water by mixing "ice, water and sal-ammoniac or salt."

In a paper (also in Latin) which he contributed to the *Philosophical Transactions* of 1724, on the subject of "Experiments concerning the Freezing of Water," he described his thermometer, but did not explain his reasons for adopting the particular scale. It may be safely assumed that he was acquainted with the paper published in 1701 referred to above.

Having then decided upon the use of mercury in his thermometer in place of the oil previously used, the problem upon what basis his scale should be constructed would next arise. What could be more natural than to base it upon the expansion of mercury itself? The idea of making his degree or unit that difference of temperature by which the liquid expands by one *ten-thousandth part of its volume* would naturally occur to him, for it had already been done in the case of the oil thermometer. That this is the basis of the Fahrenheit scale I think is proved by the fact that for each degree of the Fahrenheit scale mercury *does* expand by one ten-thousandth part of its volume.

Having, therefore, determined upon the size of his divisions or degrees, the next thing was to fix on a zero or starting point. What, again, could be more natural than to start with the greatest degree of cold which he knew how to produce, namely, the temperature of the ice and salt mixture? Having settled upon this, everything else follows, and we have the Fahrenheit scale as we know it to-day. The thermometer registers for freezing point 32°, blood heat 98½°, and boiling point 212°. In his own description of his thermometer, he states that the temperature of the body is 96°, but this slight error was probably due to the thermometer not being properly heated by that part of the body to which it was applied, and in any case does not affect this explanation, which, I think, suggests that the Fahrenheit scale is based upon scientific principles, and is not, as is often supposed, a scale without rhyme or reason.

GILBERT S. RAM.

The Inheritance of Mental Characters.

I QUITE agree with Prof. Cockerell that further discussion of this subject had better be postponed, if, indeed, it be not wholly unprofitable. But I may, perhaps, be permitted to make three remarks:—

(1) The coefficient of correlation is a measure of the degree of resemblance between brothers. We are told it may be due to "soul," heredity or environment. "Soul," I take it, can only contribute to likeness between brothers, if they have like "souls." If so, I suppose the likeness of "soul" is due to inheritance of "soul," and I do not see how this is going to be distinguished from other forms of heredity. I am not unaware of Dr. Wallace's views on spirit hierarchies. I considered them in my "Grammar of Science," and still hold them thoroughly illogical and unscientific.

(2) What I asked Prof. Cockerell to do was to explain why the intensity in inheritance of mental and physical qualities came out the *same*. He may have views why they ought to be different, but it remains for him to explain why soul + heredity + environment in one case = heredity + environment in the other.

(3) I believe the mental characters in man are far more persistent than Prof. Cockerell credits them with being. The relations between head-measurements and intelligence are almost identical whether we deduce them from young children or undergraduates, and there is no apparent change of correlation when we compare brothers at close and at more distant ages. It is perfectly possible to determine from our data the proportions of children at each age with given mental characters. Prof. Cockerell belongs to those critics who live in the region of "may-be." If he will collect observations on some 5000 to 6000 children as we have done, he may still come down from the region of "may-be" and be able to place fact against fact.

University College, London. KARL PEARSON.

The Colours of Wings in Butterflies.

YOUR correspondent in India, W. G. B. (NATURE, February 13, p. 344), has been examining a butterfly in some ways like the *Morpho Cypris* of South America, the difference being that the latter has the upper side brilliant and the lower side brown.

The Morpho can be placed so that the two wings on one side of the body are metallic blue, while the other two are black; with a slight turn the two sides reverse colours. This seems to be like the case of the Purple Emperor, in which all edges of the scales facing one way are blue, and other edges are brown. A ploughed field with furrows running east and west might after snow and sunshine appear white from the north and black from the south. In London it is easy to see the Morpho; instead of the furrows it is possible to take for illustration a common form of advertisement.

The Morpho, like the Indian specimen, presents shades of ultramarine, peacock-blue, and sea-green; also in transmitted light the scales are golden. In most cases of coloured surfaces we are not yet able to point out the action on the light waves. Prof. Tyndall showed how small particles in air or water might reflect blue waves and allow the larger red waves to curl round them and go forward; but this does not apply to a surface which reflects the larger waves. It can only be said that coloured surfaces are such as have the power at a minute depth of selecting some waves for reflection; in the case of gold leaf or some butterflies' wings, the remainder of the light may be seen, transmitted almost without any loss by absorption, as the thickness traversed is so

minute. It is familiar knowledge that the intensity and the polarisation of reflected and transmitted lights vary with the incidence; and it seems likely that in the Morpho the changing tints of blue may arise through a varying partition of the reflected and transmitted colours. While, then, diffraction does not usually affect the appearance of the wings, it is, however, interesting to a student in optics to use the scales for experiment. Let a few wings, light-coloured for preference, have the scales scraped off on to a piece of glass, and let these be covered with glass as in a lantern slide; when they are placed in strong sunlight, there is the appearance of so many minute sparkling diamonds.

Since I wrote before, I have felt that in humming-birds also the colour is seldom due to diffraction. In one which I have before me, the head is red or black, the breast is golden or olive-green; the details of the feathers have two colours, one on each edge. They are strong mixed colours, not like spectrum colours of any order. In the Gould collection at South Kensington I was, however, able to find two birds—*Rhodopis vesper* and *Calypte annae*—in which the pigment colours were so subdued that diffraction lights were able to have some influence in the mixed effect. W. B. CROFT.

Winchester College, February 17.

Birds attacking Butterflies and Moths.

IN connection with the controversy on the above subject, I am permitted to add the testimony of an old friend of mine, Mr. H. S. Wise, of Ford, Drewsteignton, South Devon, an extremely keen and accurate observer, with wide experience both of British and Indian fauna. In letters to me dated February 9 and 12, 1902, he says:—"I have seen birds attack butterflies both in England and in India," and gives the following notes:—"On summer evenings, magpies hunt a grass field and catch immense numbers of moths, beetles and, I believe, butterflies. . . Last summer I shot a magpie, one of a family that was carefully working a large grass field; his beak was full of recently-caught Swift Moths (*Hepialus lupulinus*)." Later he says, "I have seen the common spotted flycatcher pursue a butterfly and miss it, giving up the pursuit; this was of course on the wing." Further, "titmice eat quantities of small moths, which they catch when at rest." Speaking of the large Yellow Underwing (*Tryphoena pronuba*), Mr. Wise tells me, "several small birds eat this moth, sparrows among the number; it is a strong moth, and the bird generally beats it on the ground to kill it before eating it. This insect is fond of lying on the ground among leaves, &c., and birds will hunt it out and catch it." Among other enemies of British Lepidoptera, Mr. Wise notes that "bats feed largely on the night-flying moths; *Tryphoena ianthina* is one I have seen them catch." My friend also refers to a note by G. C. Dudgeon, in the Journal of the Bombay Natural History Society for March 20, 1895, on the King Crow (*Dicrurus longicaudatus*) catching a butterfly (*Teinopatpus imperialis*, ♂), and adds, "In the case of a jungle-fire in an Indian forest, birds at once come and catch the numerous insects which fly up for safety, the above-mentioned King Crow being always to the fore." In India also lizards are formidable enemies to Lepidoptera. Mr. Wise says, "in Bombay there is hardly a lamp-post which has not got a gecko on it; these feed on the moths which are attracted to the light."

Mr. H. S. Wise, I am glad to say, promises to devote especial attention this summer to the question of birds attacking Lepidoptera, and to note, whenever possible, the name of the bird and the victim. If naturalists would more generally devote time to such work, we should soon accumulate sufficient direct evidence of the severity of the struggle for existence to place the matter beyond the possibility of dispute.

I regret to find that in my previous letter (p. 299) I unintentionally added a word to Mr. Latter's phrase, which should read "relinquished its hold in consequence of a luckily-aimed stick"—not "*only* relinquished," &c. The difference is not, however, essential, as the stick is stated to have been a cause of the bird's action. LILIAN J. VELEY.

20 Bradmore Road, Oxford, February 15.

ONE morning in 1901 (actual date not recorded) I found a Humming-bird Hawk (*Macroglossa stellatarum*) on a window in my house. I opened the window and tossed it out, thinking it would fly away, but it fell to the ground, where it remained quivering its wings within six feet of me.

A House Sparrow flew down from a Deodar, and with four dexterous pecks separated the wings from the thorax; it then pecked the middle of the thorax, splitting it, and with one or two more pecks separated the abdomen from the thorax. Taking the abdomen in its beak, the sparrow flew back to the tree from which it had come and, I presume, made a hearty breakfast.

The sparrow attacked the hawk in such a business-like way that it was obviously no new proceeding on its part.

There is always a martin's nest in my porch, and it is not uncommon to find wings and thorax of Agrotis, &c. on the seats or floor. JOHN HARTLEY DURRANT.

Merton Hall, Thetford.

The Severn Bore.

SINCE writing to you on February 12, I have had the opportunity of observing the bore of this morning, a tide which corresponds with that of February 12, 1899, which was remarkable. But to-day's "head" was a very poor one indeed, for no reason that I can find out; no wind and no fresh water in the river of any consequence. The only measure that I could make was of the wave at the shore, which at one point, and one point only, rose to 2¼ feet, whilst in midstream there was but little visible.

A distance of 520 yards having been measured out, and the time of passage having been taken by watches, I found that the speed was a fraction under 15 miles per hour.

The period occupied by the passage of the "head" from Newnham ferry was one hour; the mileage taken from the Ordnance map is a little over ten miles; average speed is, therefore, ten miles per hour.

This average cannot be far from correct, for I measured at Newnham, where the river is broad, and with wide sand-banks, which spread out on either side, up to Framilode, a distance of 5·2 river-miles, and here the banks begin to approach one another, and at five miles further up the stream is only 250 feet wide. E. W. PREVOST.

Newnham, February 24.

Beautiful Birds.

IN reviewing my child's book, "Beautiful Birds," F. E. B., writing in your columns, says, "Why should he select the 'beautiful birds' only, and, by implication, condone the massacre of birds that have not that advantage?" The question is a misstatement of fact, which I hope you will allow me to show, though I can only do so by quoting myself. On the last page—which I daresay F. E. B. did not get to—there is this: "'Mother, promise not to wear *any* feathers except the beautiful ostrich feathers that you look so *lovely* in?' As soon as she has promised, then all the beautiful birds in the world (and that means all the birds, for all birds are beautiful) will be saved," &c. (The italics are mine). This is the final promise and the goal to which I have been leading. May I ask F. E. B. whether, if he wished to arouse a child's interest and sympathies in any subject, he would choose the more or the less salient material to do it with?

19 Clarence Square, Cheltenham, Feb. 9. EDMUND SELOUS.

I ADMIT that I did not observe the phrase which Mr. Selous quotes from his book. But supposing that he can quote half-a-dozen such, I cannot allow that my observations to which he takes exception contain any injustice to him or real misstatement of fact. I would commend to Mr. Selous Dr. Samuel Johnson's sound remark concerning a quite analogous statement. An orchard, observed the Doctor, would be properly described as barren of fruit, even if subsequent research discovered a dozen apples and pears upon two or three trees. Now Mr. Selous' book is called "Beautiful Birds." It is not called "Birds." It is clear, too, what Mr. Selous means by "beautiful." His plates and the greater part of his descriptions deal with the Paradiseidæ, Humming Birds, and other birds which everyone calls beautiful. I do not find chapter after chapter relating to partridges, quails, sparrows, and other "plain" birds.

F. E. B.

King Og's Bed.

A HEBRAIST once told me that he thought that Og's iron bed, mentioned in Deuteronomy iii., 11, was a sarcophagus of basalt. The Hebrew word is "barzel," which is evidently the same as the Ethiopic "basal," iron, which Stormonth's dictionary gives as the derivation of "basalt." O. FISHER.

Harlton, Cambridge, February 20.

THE ROYAL SOCIETY AND THE PROPOSED ACADEMY.

A COPY of the following petition referring to the proposed British Academy has been sent to us for publication:—

To the KING'S MOST EXCELLENT MAJESTY IN COUNCIL

The Humble Petition of

AVEBURY, F.R.S., P.C., Past President, British Association
C. ROBERT SPENCER, P.C., M.P.
WELBY, G.C.B., Past Permanent Secretary of the Treasury, Alderman L.C.C.
G. F. BRISTOL
ROWLAND BLENNERHASSETT, Bart., LL.D., President of the Queen's College, Cork; Senator of the Royal University of Ireland
WM. DUNN, Bart., M.P.
LOWTHIAN BELL, F.R.S.
JOHN KIRK, G.C.M.G., K.C.B., F.R.S.
W. B. RICHMOND, K.C.B., R A.
W. H. WHITE, K.C.B., F.R.S., Past Director of Naval Instruction
W. H. PREECE, K.C.B., F.R.S., Past Engineer-in-Chief G.P.O.
C. W. WILSON, R.E., K.C.B., F.R.S., Past Director-General Ordnance Survey
J. NORMAN LOCKYER, K.C.B, F.R.S., Director Solar Physics Observatory, South Kensington
R. GIFFEN, K.C.B., F.R.S., Past Controller-General of Commercial Labour and Statistical Department Board of Trade
SPENCER WALPOLE, K.C.B, Past Secretary of the Post Office
WM. TURNER, K.C.B., F.R.S., President of the General Medical Council; Past President of the British Association
HENRY CRAIK, K.C.B., Secretary Scotch Education Department
DONALD MACKENZIE WALLACE, K.C.I.E., K.C.V.O.
B. BAKER, K.C.M.G., F.R.S.
A. E. BATEMAN, K.C.M.G., Comptroller-General for Commerce, Labour and Statistics Board of Trade
ARCHIBALD GEIKIE, F.R.S., Past Director-General of Geological Survey; Past President of the British Association
WILLIAM CROOKES, F.R.S., Past President of the British Association
H. T. WOOD, Secretary of the Society of Arts
W. MARTIN CONWAY, Slade Professor of Fine Arts, Cambridge University; Past Chairman of the Society of Authors
JOSHUA G. FITCH, Past Chief Inspector of Training Colleges
LAUDER BRUNTON, F.R.S., Physician to St. Bartholomew's Hospital
OWEN ROBERTS, Clerk to Worshipful Company of Cloth-Workers
WEMYSS REID
C. HUBERT H. PARRY, Professor of Music, Oxford University
J. BENJAMIN STONE, M.P.
WALTER PARRATT, M.V.O., Master of the King's Musick
WALTER FOSTER, M.D., D.C.L., M.P.
JOSEPH LEIGH, M.P.
LEWIS MORRIS
R. R. HOLMES, C.V.O., Librarian to His Majesty at Windsor; Fellow and Member of Council of the Society of Antiquaries
E. ROBERT FESTING, F.R.S., Director Science Museum, South Kensington
E. W. BRABROOK, C.B., Chief Registrar of Friendly Societies; F.S.A., Past President Anthropological Institute
D. R. FEARON, C.B., Charity Commissioner
EDWARD DICEY, C.B.
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R. MELDOLA, F.R.S., Professor of Chemistry Finsbury Technical College
HORACE T. BROWN, F.R.S.
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REGINALD L. POOLE, Lecturer in Diplomatic in the University of Oxford
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GEORGE BRODRICK, Warden of Merton College, Oxford
ALEX. CRUM BROWN, F.R.S., Professor of Chemistry University of Edinburgh
JAMES GEIKIE, F.R.S., Professor of Geology University of Edinburgh
E. A. SCHÄFER, F.R.S., Professor of Physiology University of Edinburgh

BEN. N. PEACH, F.R.S., H.M. Geological Survey
JOHN HORNE, F.R.S., Assistant Director of the Geological Survey for Scotland
C. LLOYD MORGAN, F.R.S., Professor of Biology and Geology in University College, Bristol
SYDNEY YOUNG, F.R.S., Professor of Chemistry in University College, Bristol
W. BOYD DAWKINS, F.R.S., Professor of Geology and Palæontology in the Victoria University, Manchester
R. T. GLAZEBROOK, F.R.S., Director National Physical Laboratory
H. B. TRISTRAM, F.R.S., Canon of Durham
H. KYNASTON, D.D. (Camb.), Canon of Durham and Professor of Greek in the University of Durham
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ARTHUR SMITHELLS, F.R.S., Professor of Chemistry Yorkshire College
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ADAM SEDGWICK, F.R.S., Reader of Animal Morphology University of Cambridge
W. ALDIS WRIGHT, Vice-Master Trinity College, Cambridge
THOMAS SHAW, K.C., M.P.
WILLIAM RAMSAY, F.R.S., Professor of Chemistry in University College, London
H. CHARLTON BASTIAN, F.R.S., Emeritus Professor of Medicine University College, London
F. A. CHANNING, M.P., Past Lecturer in Philosophy University College, Oxford
WM. ALLAN, M.P.
ISAAC BAYLEY BALFOUR, F.R.S., King's Botanist in Scotland
FRANCIS ELGAR, F.R.S., Past Director of H.M. Dockyards
N. BODINGTON, Litt.D., Principal, Yorkshire College
FRANK E. BEDDARD, F.R.S., Vice-Secretary Zoological Society

Sheweth

That Whereas His Majesty King Charles II., in order to prove that His Majesty did "look with favour upon all forms of Learning" and particularly "Philosophical Studies," and in order that such Learning and Studies should "shine conspicuously" among his People, did by Charters granted in the 14th, 15th and 21st years of His Reign found the Royal Society for the promotion of such Learning and Studies

And Whereas the progress of Learning and Philosophical Studies has been great, and scientific methods of inquiry have been applied to many new fields of knowledge since the time of His Majesty King Charles II.

And Whereas Your Petitioners are of opinion that it is desirable that all the Intellectual forces of the Realm should be so organised as to promote the greatest advancement of Scientific Studies within the Empire

And Whereas a large and influential group of representatives of Studies connected with History, Philosophy and Philology have lately presented a petition to Your Majesty praying to be embodied under Royal Charter as an Academy or like institution

And Whereas Your Petitioners are of opinion that such incorporation can be most efficiently provided for in some relationship to the Royal Society

We Your Petitioners humbly pray that Your Majesty may be graciously pleased to cause an Inquiry to be made with a view of instituting a general and formal organisation of all the Studies depending upon Scientific Method now carried on similar to that inaugurated for the Philosophical Studies of the 17th century by the Charters of His Majesty King Charles II.

And Your Petitioners will ever pray,

POSITION AND PROMISE OF WIRELESS TELEGRAPHY.

THE meeting of Marconi's Wireless Telegraphy Company held last week was of more interest than such meetings usually are, as Mr. Marconi made use of the opportunity by replying in a long speech to the many adverse criticisms which had been passed on his work. No new development has ever been brought about without having to encounter a certain amount of opposition; wireless telegraphy is no exception to the general rule, and the criticism which it has had to meet has been accentuated on account of the magnitude of the interests vested in cable enterprise. But wireless telegraphy has also enjoyed more than its share of popular enthusiasm, and it is perhaps partly on account of the unreasoning nature of this enthusiasm that technical writers have thought it desirable to sound a warning note. It is doubtless unnecessary to sell out cable shares immediately because the signal "S" has been successfully transmitted across the Atlantic, but it is equally unnecessary to assume that the result is not genuine before the details of the experiments have been published. With reference to these recent experiments, and the suggestion put forward by some of the technical papers that Mr. Marconi was deceived by atmospheric disturbances, he appeals, we think with justice, to his long experience in the matter as sufficient guarantee of the genuineness of the result, and points out that in his first successful experiment over 200 miles it was the same signal that was received.

The question has often been asked, Why is it that, if a distance of 2000 miles can be bridged, the system is not in actual commercial operation over shorter distances?

To this Mr. Marconi replies that the Post Office monopoly prevents its adoption round the coasts of this island, but that it is in continuous and perfectly satisfactory work in connection with more than seventy ships and twenty-five land stations, as readers of NATURE are aware from paragraphs which have appeared from time to time in our Notes columns.

The greatest interest, however, centres around the questions of the speed and the secrecy of signalling. Mr. Marconi states that with his latest apparatus a speed of twenty-two words a minute is obtainable. For short distances much higher cable speeds are possible, but in Transatlantic work the speed of signalling under the best conditions is only about forty words per minute, so that in this respect wireless telegraphy can certainly become a serious competitor. Distance, it is stated, has no effect on the rapidity of signalling by ætheric waves, a result which was, of course, to be anticipated on theoretical grounds.

As to secrecy, Mr. Marconi asserts that the development of his syntonic system has been carried so far that no interference troubles need be feared, and quotes an interesting example in support of this contention. The permanent station at the Lizard is at present able to work with ships without suffering any interference from the working of the big-power station at Poldhu, only seven miles distant, from which the signals were transmitted to Newfoundland. The solution of the problem of tuning has always been seen to be of fundamental importance to wireless telegraphy, and if Mr. Marconi has successfully achieved this result, it is a development greater and more far-reaching than even the Transatlantic signalling. That he is himself confident of having done so may be inferred from the challenge which he issued to Sir W. Preece and Prof. Lodge to intercept and read any of his messages, for which purpose he offers to put any of his adjacent stations at their disposal.

At the present day, when the general public takes

so much interest in scientific progress, any new development becomes so soon the centre of numberless contradictory and inaccurate reports that it is often difficult to get at the truth of the matter. Mr. Marconi's authoritative statement last Thursday is therefore very welcome. Even those most sceptical of the ultimate value of the discovery cannot but admire the energy and perseverance which Mr. Marconi has shown throughout. Whilst others have been pointing out its impracticability, he has been steadily making it practicable, and, considering the splendid results which he has already achieved, one cannot help sharing his confidence in his ultimately attaining complete success. M. S.

PROF. I. V. MUSHKETOFF.

WE regret to see the announcement of the death of Prof. Ivan Vasilievich Mushketoff, the president of the physical geography section of the Russian Geographical Society, at the age of only fifty-two.

Prof. Mushketoff was from the Don region, where he was born in 1850, and received his early education at the Novocherkask lyceum. In 1867 he entered the St. Petersburg University, joining the philological faculty, but soon went over to the Mining Institute.

Already while a student he published his first original research on the Volhynite, and in 1872 he began his continuous, almost uninterrupted explorations of Russia, first in the Urals, where he discovered a gold-bearing formation of arsenicated minerals—pharmacosiderite, arseniosiderite, &c.—and then on the Don. Next year, 1873, he was in Turkestan, where he remained for six years, making extensive journeys. He embodied the results of his explorations in a great number of geological and geographical papers, as also in a remarkable work, "Turkestan," vol. i. (1886), which was described in these pages, and, with Prof. Romanovsky, in a geological map of Turkestan.

In 1881, Mushketoff began the exploration of the Caucasus, and especially of the Astrakhan, the Kalmyk and the Kirghiz steppes, and later on of the Transcaspian region, of which he published an excellent geological description, with a map, in 1892.

A second journey to Turkestan, in order to explore the earthquake at Vyernyi, brought Mushketoff to the study of earthquakes in Russia, for which purpose numerous regular observations and a catalogue of earthquakes (by Orloff) were published by him in the periodicals of the Geographical Society. Later on he became interested in glaciers, and organised for the International Commission on Glaciers the first regular observations in Russia upon the oscillations of the glaciers of the Caucasus. All these researches enabled him to publish the first volume of an excellent course of physical geography (1891) and a short course of petrography (1895). In 1882 he was nominated head geologist of the Geological Committee, and took, in this capacity, a lively part in the geological survey of Russia. From 1885 he was president of the physical geography section of the Russian Geographical Society, and in this capacity he took, with P. P. Semenoff, the liveliest part in the organisation of all the expeditions of the Society, as well as in its publications, of which the "Annuary" is perhaps the most remarkable for the fulness of information about all geographical, geological, geo-botanical, geo-zoological and anthropological work done in Russia.

In Mushketoff, both Russia and science have lost one of their best physical geographers. He was at the same time an excellent man, and the obituary notices published in the Russian papers represent him as a most sympathetic friend of the Russian youth. P. K.

NOTES.

M. C. ANDRÉ has been elected a correspondant of the Paris Academy of Sciences, in the Section of Astronomy.

THE council of the Zoological Society has resolved to bestow the gold medal of the Society upon Sir Harry Johnston, in consideration of his very great services to zoological science, and in commemoration of his discovery of the Okapi, and the silver medal of the Society upon Mr. E. W. Harper, of Calcutta, in acknowledgment of his numerous contributions of rare Indian birds to the Society's collection. These medals will be presented at the general meeting of the Society on June 19.

IN accordance with the usual custom, the French Physical Society announces that two meetings for the exhibition of experiments described before the Society during the year will be arranged for on Friday and Saturday, April 4 and 5. On the first evening members only will be admitted; the second will be open to visitors. The rooms of the Society (44 Rue de Rennes, Paris) will be open during the whole of the Saturday for those desirous of studying the experiments more at their leisure than is possible in a crowded meeting.

THE Belgian Royal Academy makes the following announcements as to awards of prizes on scientific subjects for 1901:—For the first question, as to the part played physiologically by albuminoid substances in the nutrition of animals or vegetables, no award has been made. For the second question, relating to the organisation and development of a Phoronis, one essay has been submitted which has been adjudged worthy of honourable mention. On the subject of the effect of external influences on karyokinesis and cell-division in plants, an essay has been submitted by Mdlle. Maria Maltaux, of Laeken, to whom a silver medal has been awarded. The Charles Lemaire prize has been awarded to M. Paul Christophe, engineer of the Belgian "Ponts et Chaussées."

MR. CARNEGIE'S gift of ten million dollars, in 5 per cent. bonds of the United States Steel Corporation, for the promotion of scientific research, has already been announced in these columns, and an outline has been given of the Carnegie Institution to be founded for this purpose (pp. 278, 302). A meeting of the trustees of the institution was held at the end of January, when Mr. Carnegie described briefly the object he had in view in making the gift, and gave emphasis to his repeated desire that the income of the fund should be largely devoted to extending human knowledge by original investigation and research. The methods by which knowledge is to be advanced are left to the free action of the trustees, who will await the carefully matured suggestions of the executive committee. "Nothing," says *Science*, "has been done in founding the new institution to further or to hinder the establishment of a national university which has been so many times proposed to Congress. Nothing is projected which will in any way interfere with the purpose of the George Washington Memorial Association to secure the funds requisite for the erection of a memorial building. Nor has there been any step taken which will prevent the Washington Memorial Institution, initiated early in the last summer, from developing plans for the introduction of students to the various scientific bureaus of Washington. The Carnegie Institution is simply a new force for the promotion of science, ready to cooperate with other institutions which are now or may be established in Washington or elsewhere."

THE Russian Geographical Society has awarded this year its Constantine medal to the geologist, K. I. Bogdanovitch, who has spent several years in the exploration of Central Asia and

has contributed one large volume to the beautiful series of quarto volumes edited by the Society and devoted to this part of Asia. The Semenoff medal has been awarded to Prof. Eduard Suess for his new classical work, "Das Antlitz der Erde," and the Prjevalsky medal to the zoologist, Prof. Zarudnyi, the author of several most valuable works on the birds and also the geography of the Transcaspian region, and the author of a work, "Journey to East Persia," just published by the Society. The great gold medal of the Section of Statistics has been awarded to N. V. Slyunin, for his researches into the economical conditions of the inhabitants of the Okhotsk and Kamchatka coasts. Three small gold medals have been awarded to Messrs. N. P. Petrovsky, D. K. Zelenin and M. N. Kositch for ethnographical works published in the excellent ethnographical periodical of the Society, *Zhivaya Starina* (*Living Antiquities*). Prof. Gordyaghin, of Kazan, has been awarded the Prjevalsky silver medal for his botanical work in East Russia, and the Semenoff silver medal has been awarded to A. K. Bulatovich for his journey to Lake Rudolph. A number of small silver medals have also been awarded, chiefly for meteorological work in connection with the Society's meteorological committee, or for expeditions.

THE Elizabeth Thompson Science Fund, "for the advancement and prosecution of scientific research in its broadest sense," now amounts to 5200*l.*, and grants will be made in November from the income derived from this sum. This endowment is not for the benefit of any one department of science, but preference will be given to those investigations which cannot otherwise be provided for, which have for their object the advancement of human knowledge or the benefit of mankind in general, rather than to researches directed to the solution of questions of merely local importance. Applications for assistance from this fund, in order to receive consideration, must be accompanied by full information, especially in regard to the precise amount required; exact nature of the investigation proposed; conditions under which the research is to be prosecuted; and manner in which the grant asked for is to be expended. All applications should reach the secretary of the Board of Trustees, Dr. C. S. Minot, Harvard Medical School, Boston, Mass., U.S.A., before April 1. During the past twelve months, the following grants have been made:—30*l.* to Prof. E. W. Scripture, New Haven, Conn., for work in experimental phonetics; 60*l.* to Prof. W. Valentiner, Heidelberg, for observations on variable stars; 10*l.* to Mr. A. M. Reese, Baltimore, Md., for investigation of the embryology of the alligator; 25*l.* to Dr. F. T. Lewis, Cambridge, Mass., for investigation of the development of the vena cava inferior.

ON March 5, the Hon. Alan de Tatton Egerton, M.P., will read a paper to the Cold Storage and Ice Association, of which he is president, at the Institution of Mechanical Engineers, on the cold stores and ice factory at Knutsford.

IT is reported that Prof. Virchow continues to make satisfactory progress towards recovery. He is now permitted to make some attempts to walk, and it is hoped that he will in time regain the full use of the injured limb.

WANT of knowledge of the principles and results of vaccination and of antitoxin treatment is responsible for many incorrect opinions and for opposition to medical research. The Vaccination League has been formed with the object of extending the knowledge of the subject of vaccination, and thus, to some extent, counteract the erroneous impressions received from pamphlets prepared by anti-vaccinationists. Among the influential names recently added to the long list of vice-presidents of the League are those of the Bishop of London, Archdeacon Sinclair and Lord Newton. It will be remembered that Lord Newton recently introduced a Bill into the House of Lords on the question of vaccination. Those who are desirous of obtaining free literature dealing with the advantages of vaccination, or of organising popular illustrated lectures on the subject in their respective districts, should apply to the secretary of the Vaccination League, 110 Strand, W.C.

THE anniversary meeting of the Geological Society was held at Burlington House on Friday last (February 21). The officers were appointed as follows:—President, Prof. C. Lapworth, F.R.S.; vice-presidents, Sir Archibald Geikie, F.R.S., Mr. J. E. Marr, F.R.S., Prof. H. A. Miers, F.R.S., and Prof. H. G. Seeley, F.R.S.; secretaries, Mr. R. S. Herries and Prof. W. W. Watts; foreign secretary, Sir John Evans, K.C.B., F.R.S.; and treasurer, Dr. W. T. Blanford, F.R.S. The following awards of medals and funds were made. The Wollaston medal to M. F. Schmidt, of St. Petersburg; the Murchison medal to Mr. F. W. Harmer; the Lyell medals to Prof. Anton Fritsch and Mr. R. Lydekker, F.R.S.; the Wollaston fund to Mr. L. J. Spencer; the Murchison fund to Mr. T. H. Holland; the Lyell geological fund to Dr. Wheelton Hind; and the Barlow-Jameson fund to Mr. W. Hutchings. The president delivered his anniversary address, which dealt chiefly with the evolution of ideas during the nineteenth century as to the genesis and classification of sedimentary and metamorphic rocks.

THE annual meeting of the Institution of Mechanical Engineers was held on Friday last. The report of the council records that the work of preparing the sixth report of the Alloys Research Committee—dealing mainly with the effect of annealing and tempering on the properties of steel—was continued in the laboratories of Sir W. C. Roberts-Austen at the Royal Mint and at the Royal College of Science until October 31; and a full report, which is now partly written, is expected to be ready during the present year. The second report of the Gas-Engine Research Committee was read and discussed at the October meeting, and the Institution has agreed to provide during the present year instruments for trials with a large experimental gas-engine which Prof. Burstall is designing to form part of the power and lighting plant in connection with the new Birmingham University Buildings. The experiments at University College, London, on the value of the steam jacket were continued during the early part of last year with the old apparatus, but were interrupted by the appointment of Prof. T. Hudson Beare to a chair in the University of Edinburgh. The apparatus has been removed from London to Edinburgh, and Prof. Beare is now designing several improvements in the valves for the admission and exhaust of the steam into the hot pots of the apparatus. As soon as these new valves are made, the experiments will be resumed, and it is hoped more satisfactory results will be obtained with this new apparatus. The series of experiments at King's College on the compound steam-jacketed engine has been completed, and Prof. David S. Capper has promised his report early this year. A second series of tests with unjacketed cylinders has been commenced, and is being carried through at the same speeds and steam pressures as the first jacketed series. Direct comparisons can then be made both with and without steam jackets. The council has joined with the councils of the Institution of Civil Engineers, the Iron and Steel Institute and the Institution of Naval Architects in forming a committee, to be called "The Engineering Standards Committee," for the purpose of recommending standard sizes for rolled sections, and other matters. The question of standardising pipe flanges, being of great importance at the present time, will be dealt with in a paper to be read before the Institution at an early meeting.

THE death is announced, at Vienna, of Dr. Emil Holub, the famous African explorer. From an obituary notice in the *Times*, we learn that Dr. Holub, who was a native of

Bohemia, was of Czech descent. He was born in the small town of Holics on October 7, 1847. After practising for a time as an apothecary, his scientific leanings and his adventurous spirit led him, at the age of twenty-five, to emigrate to South Africa. His principal inducement to explore the land beyond the Zambesi was his love of natural history, and more particularly his interest in ornithology. Indeed, the first period of seven years spent by him in South Africa was mainly devoted to ornithology and to zoology in general. On his return to Europe he took up his residence at Prague, and afterwards in Vienna, where he prepared his "Beiträge zur Ornithologie Südafricas" ("Contributions to the Ornithology of South Africa"). A little later he published "Seven Years in South Africa" and "The Colonisation of Africa." At this time he devoted himself seriously to the study of astronomy and geography, having during his first journey been greatly hampered, as he was always the first to confess and deplore, by his lack of physical and mathematical knowledge. His explorations, therefore, had been rather those of a zoologist than of a geographical explorer. Having resolved to overcome this difficulty, he set to work, and when, in 1883, he landed on African soil for the second time he was probably as well equipped as any of his predecessors in African exploration. After a little delay, Dr. Holub proceeded to the country of the Mashukulumbe, into which he penetrated further than any European had done before him. There, accompanied by his wife, he spent four years, returning to Europe in 1887. His book, entitled "From Cape Town to the Country of Mashukulumbe," which contains a record of his labours, has become a standard work. Like his former publications, it has been translated into many languages.

THE German Physical Society's publication, *Die Fortschritte der Physik*, has, under the editorship of Profs. Scheel (for pure physics) and Assmann (for cosmic physics), fairly succeeded in attaining the maximum efficiency in keeping up to date with the most recent papers, consistently with its appearance as a yearly volume. In order to accelerate further the issue of a summary of current literature, Messrs. Fried. Vieweg and Son, of Brunswick, now announce the publication, in connection with the *Fortschritte*, of a *Halbmonatliches Litteraturverzeichniss*, which will furnish the physicist at fortnightly intervals with a list of papers and books classified under the various branches of physics. The first and second numbers contain forty and twenty pages respectively. The titles only of the papers are given, so each page contains the names of some five-and-twenty different papers. The subscription price of the *Litteraturverzeichniss* is only 4 marks per annum, so it should soon find its way into the library of every physicist.

THE *Bulletin* of the French Physical Society, No. 174, describes briefly some important experiments by M. Marey on the motion of fluids studied by photography. In the case of liquids, M. Marey was successful, as long ago as 1893, in studying the motions by means of beads of the same specific gravity as the liquid. He has recently succeeded in studying the movement of air-currents past a fixed obstacle by means of smoke filaments, obtained by filtering the air-current through silk gauze with even meshes, the smoke being photographed by means of magnesium light. Where no obstacle exists, the filaments of smoke are rectilinear and parallel, while if an inclined plane be placed in the current, they will be seen to indicate the form of the stream lines, some bending round the upper and others round the lower edge. To obtain the velocity of the current at different points, a lateral oscillatory motion of ten periods per second is given to the screen, when the smoke filaments assume a sinusoidal form which is preserved throughout their path and the distance between the inflexions at any point determines the velocity. When the experiments were repeated under identical conditions, the two images were found to agree to such an extent as to be capable of superposition.

IN connection with the wreck of *Santos Dumont* No. 6, Dr. J. Y. Buchanan, F.R.S., has written a letter to the *Times* which may serve to correct any false impressions that may have been formed as to the value or general conclusions of the experiments. It is pointed out that "to M. Dumont himself every fresh ascent, whether the public term it a success or a failure, is full of lessons on a quantity of matters of detail of which the uninitiated can have no perception. Indeed, the more complete the apparent failure, the greater is the value of the experience to the air pilot, provided he escape so as to be able to utilise the experience himself." Since Dr. Buchanan arrived at Monaco, M. Dumont has taken his balloon out three times. The first time (on February 10) the balloon completely outstripped the Prince of Monaco's launch, and was even estimated to achieve 15 knots relative to the ground, going against a breeze. But "the most striking and at the same time unfavourable feature was the heavy pitching of the balloon, which at times attained an amplitude of not far from 45° on each side the vertical." On the 11th, M. Dumont performed his most successful journey in the direction of Cap Martin and back, the balloon pitching much less than previously. The accident which occurred on the 14th appears to have been mainly due to this pitching. "Arrived abreast the pigeon-shooting ground, the pitching became more violent, and the balloon rose, taking the guide-rope, which usually trails on the surface of the water, entirely out of the water and to a height of fifty yards or more above it. The situation was now becoming critical. In pitching, the balloon came to be standing very nearly vertically, first on one end and then on the other." M. Dumont appears then to have let out gas, which had the effect of causing the rear and lower end to collapse, and the rudder was thereby rendered useless. From this time until M. Dumont was rescued, wet and bedraggled, from the wreck, frequent photographs were taken showing the form assumed by the balloon during its gradual deflation. Two conclusions are drawn from the experiments; firstly, that the pitching must be prevented by the application of aëroplanes or side pieces performing the functions of bilge keels, or by other means, and, secondly, the great difficulty attaching to the ellipsoidal balloon as compared with the typical one of spherical or more strictly pear-shaped form, in that the former tends to revert to the spherical shape as soon as it is somewhat deflated, while the latter better preserves its natural form in shrinking.

A WRITER in the *Dumfries and Galloway Standard and Advertiser* (February 12) directs attention to a curious anticipation of a magnetic means of communication contained in the following paragraph from the *Spectator* of December 6, 1797:—"Strada, in one of his prolusions, gives an account of a chimerical correspondence between two friends by the help of a certain loadstone, which had such virtue in it that if it touched two several needles, when one of the needles so touched began to move, the other, though at never so great a distance, moved at the same time, and in the same manner. He tells us that the two friends, being each of them possessed of one of these needles, made a kind of a dial plate, inscribing it with the four and twenty letters, in the same manner as the hours of the day are marked upon the ordinary dial plate. They then fixed one of the needles on each side of these plates in such a manner that it could move round without impediment so as to touch any of the four and twenty letters. Upon their separating from one another into different countries, they agreed to withdraw themselves punctually into their closets at a certain hour of the day, and to converse with one another by means of this their invention. Accordingly, when they were some hundreds of miles

asunder, each of them shut himself up in his closet at the time appointed and immediately cast his eyes upon his dial plate. If he had a mind to write anything to his friend, he directed his needle to every letter that formed the words which he had occasion for, making a little pause at the end of every word or sentence to avoid confusion. The friend, in the meanwhile, saw his own sympathetic needle moving of itself to every letter which that of his correspondent pointed at. By this means they talked together across a whole continent, and conveyed their thoughts to one another in an instant over cities or mountains, seas or deserts."

PROF. A. AGASSIZ and his party have returned to Colombo, after spending a few weeks in the exploration of the Maldives. From the *Ceylon Observer* we learn that about three hundred photographs were taken, principally of coral-reef subjects. The principal work done was the sounding of the channels between the lagoons and the development of the plateau on which the atolls of the Maldives have been formed. The principal atolls are separated by comparatively shallow water in the central part of the group, while towards the south, between Hadumati and Suvadiva and Addu, the depths are very much greater—nearer a thousand fathoms. A line was run to the westward of Ari Atoll into fifteen hundred fathoms, and one to the southward of South Male into twelve hundred fathoms, showing that the plateau of the Maldives is much steeper on the west than on the east face. Soundings were also taken between the northern Maldives and Colombo, and they show that the Maldives are separated from the Indian continental slope by a deep bank of the ocean of more than fifteen hundred fathoms in depth. The atolls of the Maldives are said to exhibit the most simple and primitive conditions for the formation of atolls which are found anywhere except in some parts of the Yucatan plateau in the West Indies. Atolls can be found in all stages of growth, from a mere bank rising to a few feet above the plateau to banks within five or six fathoms from the surface or to banks which have just reached the surface and on which sandbanks or islets are beginning to forms. Prof. Agassiz says that one reason for the success of his expedition is that the charts published more than seventy years ago are as accurate to-day as they were then. The only changes noticed were changes such as the washing away of banks or the formation of banks since the charts were published; but these are changes without any special importance.

WE have received the Report of the Meteorological Commission of the Cape of Good Hope for the year 1900. The Commission has had to contend with considerable difficulty owing to the irruption of hostile bands into Cape Colony and the wanton destruction of many instruments. Nevertheless, it is able to report that the interest shown in the subject both by observers and the general public continues to grow, and that observations have been restarted at Johannesburg and Kimberley. Compared with the previous year, there has been a considerable increase in the number of observers, especially at rain-gauge stations, which now number 447. An investigation is being made into the connection between the weather and the plague in Cape Town. The result goes to show that each marked rise in temperature was followed in a period of from ten to fourteen days by an increase in the number of plague cases. The Commission has also taken up the investigation of ocean currents with the cooperation of the Union-Castle Steam-ship Company, whose captains are instructed to throw bottles overboard at fourteen different points along the coast. Among various papers which have recently been read before the South African Philosophical Society may be mentioned one of especial interest on some periodical changes in the rainfall at the Royal Observatory, since 1841, by Prof. J. T. Morrison, in which evidence is shown of two prevailing periodicities running simultaneously through the monthly amounts, and completing themselves in ten years and in slightly over nine years respectively. The author also finds a well-marked periodicity of about sixty years, but its exact period has not yet been determined.

THE Meteorological Office pilot chart of the North Atlantic and Mediterranean for the month of March states that, although there is a general diminution in the strength of the winds at this season, gales are still of frequent occurrence, especially on the western half of the ocean, where, over a considerable area, the frequency is from 25 to 36 per cent. This locality is indicated on the inset chart of mean barometric pressure by a closing up of the isobars. The prevalent north-easterly winds in the neighbourhood of the British Isles are associated with the dipping of the isobars south-eastwards towards Spain. On the Gulf of Mexico the "northers" are becoming less frequent, but they undergo certain important modifications. They are shorter in duration and are accompanied by finer weather, but they blow with greater violence during the first twenty-four hours of their continuance and draw less to the north-east. Fog on the Banks having reached its minimum in February is now spreading east and west, and mariners are cautioned against hugging the coasts of the United States during the prevalence of east winds, and particularly gales, as the low shores are then hidden in fog. Two inset charts are given to illustrate the north-easterly type of weather over western Europe, one being the blizzard of March, 1891, when many of our southern counties were buried deep under snow. One result of the presence of these spring north-east winds is seen in their marked influence on the currents. Not only is there a south-westerly set traceable from the Channel soundings, but even northward of the 50th parallel there is a westerly flow to about 22° W., where it curves to southward and south-eastward and merges in the south-westerly set near the 40th parallel. The Gulf Stream water is thus kept away from our south-western shores at this season, but out on the ocean its flow can be traced north-eastward to the neighbourhood of Rockall. No ice appears to have been reported since the early part of December.

THE issue of the pilot chart referred to in the foregoing note completes the series for a whole year, and investigators have now at their service a most valuable summary of the salient features of the various elements month by month. The circulation of the ocean waters will attract most attention, because the currents of the Atlantic have never before been published for each of the twelve months, and as the results here given are based on observations extending over the very long period of sixty-five years, they are as complete as can be hoped for. Commander Hepworth has been singularly successful in his selections of weather types and other matter for the several months, many of them being justified in the course of the period covered, such, for instance, as the northerlies in May, the summer thunderstorms, the September hurricane near the Cape Verde Islands, the recent exceptionally high barometer (31·11 in.), and the dust storm off north-west Africa in January, &c. Reports from different parts of western Europe indicate very clearly that the sand precipitated in South Wales and the south-west of England on January 22 and 23 had travelled northward from the sandstorm experienced about the Canaries and Madeira on the 17th and 18th, when an easterly gale was blowing from the African mainland.

SO comparatively easy has it now become to obtain good photographs by means of flashlight that pictures of places situated under the level of the earth's surface are not uncommon. So interesting are some of these underground passages, caves and grottoes, and so great is the chance that as time goes on they will undoubtedly be

deprived of their natural charms, it seems only right that their features should be at once rendered permanent by means of photography and kept as records for future generations. As pointed out in the current number of the *British Journal of Photography* (February 14), we have not necessarily to leave our own country in search of such subterranean cavities, for we have in Yorkshire, Derbyshire, Thanet and other parts of the country grottoes which are well worth seeing and photographing. Why, then, should not these British caves be treated in the same way as has recently been done for the famous grotto of Han? This subterranean paradise, as it has been called, has lately been photographed with great success and the pictures published in a booklet entitled "The Wonders of the Grotto of Han." In some cases, magnesium light was used as an illuminant, while in others the electric light which adorns the principal galleries of the cavern was sufficient. Even if it were impossible to get sufficient light for such dark interiors by flash, the above-mentioned journal suggests that there is no reason why a time exposure should not be made, making use of a pyrotechnic composition with magnesium or aluminium as its base.

MESSRS. W. M. MORDEY and B. M. Jenkin, in their paper on electrical traction on railways, which was read before the Institution of Civil Engineers last week, dealt with the relative merits of direct-current, alternate-current and composite systems. The present time is opportune for such a paper, as the electrification of some of the larger railways is being more or less seriously discussed. In this country, as the recent Inner Circle arbitration showed, direct-current driving is favoured, the system being generally a composite one, with generation of alternating current at high voltage and conversion to direct-current at 500 volts at substations. On the Continent, as the authors pointed out, there is a tendency to work out the more difficult problems in traction work by the use of three-phase alternating current for both transmission and driving. After summing up the requirements that should be met by any general system of electrical railway working, the authors concluded that the distribution of power is best effected by single-phase alternating current. The Ward Leonard system of utilising such current was then discussed in detail; by this the current is supplied to a single-phase motor on the train which drives a dynamo, which in turn drives the direct-current train motor. This method, though it appears complex, is, they consider, the one best satisfying all the conditions for a general electric traction system.

MR. W. L. SCLATER'S illustrated notice of that remarkable bird, the ground-hornbill (*Bucorax cafer*) of South Africa, which appears in the February issue of the *Zoologist*, will be read with interest by ornithologists. These birds, which are generally seen in the open, live entirely on the ground, and wander about in parties of five or six. It is believed that several females lay in the same nest, which is situated in a hole high up in the stem of a tree.

TO the *Revue générale des Sciences* for September 15, Prof. A. Forel contributes a long article on the psychic faculties of insects. According to the author, these creatures are certainly endowed with four senses, namely sight, smell, taste and touch, the possession of hearing being doubtful. Some writers attribute to them a "photodermatic" sense, but this is merely a modification of touch. After describing the location of each of these senses, the author proceeds to discuss the powers of perception, volition and "sentiment" possessed by insects, concluding with a comparison between their intellect and that of man.

THE February number of the *Zoologist* contains Mr. T. Southwell's account of sealing and whaling for the past year. For the first time for an unknown period, no British whaler visited the sea between Greenland and Spitzbergen. Davis Strait, on the other hand, was visited by several vessels, and whales were by no means scarce, although, owing to bad weather, captures were not numerous and two whales were lost after being killed. One whale with whalebone close on twelve feet long was secured. The price of whalebone during the season was 1450*l.* per ton, but it is now said that 2000*l.* is being asked. The Newfoundland sealing was fairly successful, and was remarkable for the early date at which the vessels completed their cargoes. The Gulf sealing, on the contrary, was a practical failure.

AN influential committee has been appointed to promote a "nature-study" exhibition to be held in London about the end of July. It is suggested that the exhibition should be open to urban and rural elementary day schools, continuation schools, higher-grade schools (boys and girls), Home Office schools, secondary schools (boys and girls), and other institutions and colleges, and that prizes or certificates should be offered in each class for (1) The best collection of common dried plants, injurious insects, &c., apparatus for class lessons, drawings made in class of natural objects, home-made maps with a school as centre, showing features of interest within a radius of two or three miles of the school, note-books, natural history calendars, plans of gardens, photographs, models in clay or plasticine of natural objects, plants grown in boxes and pots, and rustic carpentry. Schools would not be restricted to these exhibits, nor would they be required to send all of them. Teachers would use their own discretion in sending what they believe will most fully illustrate their courses in "nature-study." Specimens of rare plants would not be asked for, and the uprooting of any plant would be especially forbidden. (2) The best individual exhibit of one pupil's work. (3) The best scheme of instruction and descriptive account of work, methods, &c. There should be no difficulty in obtaining the necessary funds for such an excellent object.

THE discourse on "The Discovery of the Future," delivered at the Royal Institution on January 24 by Mr. H. G. Wells, and printed in our issue of February 6, has been published in book form by Mr. T. Fisher Unwin.

MR. W. A. SHENSTONE'S little book on "The Methods of Glass Blowing" (Longmans, Green and Co.) is favourably known to all who have cultivated the art for the purposes of constructing physical and chemical apparatus and accessories. The practical hints on glass-blowing contained in the book are the result of long practice at the blow-pipe, and experience of the requirements of laboratories. The fourth edition of the book, which has just been published, contains a new chapter in which Mr. Shenstone describes the methods of working silica in the oxy-gas flame, a subject to which he has given particular attention.

THE presidential address delivered at the Philadelphia meeting of the Chemical Society by Prof. F. W. Clarke appears in a recent number of *Science*. The address deals with the development of chemistry, and is an interesting discussion of the progress and prospects of chemical science. Prof. Clarke considers that the chief need of chemistry at the present time is the better organisation of research. Whilst fully appreciating the great work that is done by individuals working independently in the field of science, he thinks that collaboration and systematisation are urgently required. He maintains that either by public expense or by private enterprise, laboratories for research should be established in all civilised countries. By conference between them, the work should be so adjusted as to avoid repetition, each one reinforcing the others. Their primary function should be to perform the drudgery of science, to undertake the tedious, laborious, elaborate investigations

from which the solitary worker shrinks, but which are, nevertheless, essential to the development of chemistry. Brilliant discoveries might be made in them, but incidentally, and not as their main purpose.

THE table of atomic weights issued annually by the international committee appears in the January number of the *Berichte*, and the table, based upon oxygen = 16, is unaccompanied by the didactic table with hydrogen = 1. The withdrawal of the didactic table is in accordance with a widely expressed wish. It is generally felt that if oxygen is to be taken as 16 for any purpose it should be taken as 16 for all purposes. Discussing this subject in a paper recently contributed to the American Society of Sciences and Arts, Prof. Richards made a strong appeal to chemists to conform to the decision of the international committee. He pointed out that oxygen has actually served as the experimental standard of reference in a great majority of cases, that the great bulk of valuable work has already been published on the basis oxygen = 16·000, and that the use of this standard involves no important didactic difficulties. He contends that the decision of the representatives of the international committee is in itself an important reason for adopting this standard, and that uniformity of usage is more important than any of the special advantages claimed by either side in the discussion. The only alterations of atomic weights in this year's table are of calcium from 40 to 40·1, iron from 56 to 55·9, and tellurium from 127 to 127·6.

THE additions to the Zoological Society's Gardens during the past week include two Guinea Baboons (*Cynocephalus sphinx*), a Red-footed Ground Squirrel (*Xerus erythropus*) from West Africa, presented by Captain R. H. Wilford; a Snow Leopard (*Felis uncia*) from Northern India, presented by Captain H. Nicholl; two Half-collared Turtle Doves (*Turtur semitorquatus*) from West Africa, presented by Captain Thorne; a Ring-necked Pheasant (*Phasianus torquatus*) from China, presented by Mr. B. Tufnell; seven Black-headed Gulls (*Larus ridibundus*), a Common Gull (*Larus canus*), European, presented by Mr. E. J. W. Eldred; a Green Monkey (*Cercopithecus callitrichus*), an Erxleben's Monkey (*Cercopithecus erxlebeni*), eight West African Love-Birds (*Agapornis pullaria*) from West Africa, a Greater Sulphur-crested Cockatoo (*Cacatua galerita*) from Australia, a Levaillant's Amazon (*Chrysotis levaillanti*) from Mexico, ten Common Toads (*Bufo vulgaris*), European, a Loggerhead Turtle (*Thalassochelys caretta*) from Tropical Seas.

OUR ASTRONOMICAL COLUMN.

ASTRONOMICAL OCCURRENCES IN MARCH.

Mar. 3. 22h. Vesta in conjunction with the moon. Vesta 0° 35′ S.
5. 15h. Saturn in conjunction with the moon. Saturn 5° 1′ S.
6. 14h. Jupiter in conjunction with the moon. Jupiter 5° 41′ S.
7. 7h. Venus in conjunction with the moon. Venus 2° 11′ N.
12. 10h. 12m. Minimum of Algol (β Persei).
15. 7h. 1m. Minimum of Algol (β Persei).
15. Venus. Illuminated portion of disc = 0·198, Mars = 1·000.
17. 2h. 0m. Mercury at greatest elongation (27° 41′ W.).
17. 9h. 19m. to 10h. 16m. Moon occults 26 Geminorum (mag. 5·1).
18. 5h. 48m. to 6h. 14m. Moon occults 68 Geminorum (mag. 5·0).
18. 15h. 19m. to 18h. 58m. Transit of Jupiter's Sat. III.
20. 8h. 27m. to 9h. 43m. Moon occults ω Leonis (mag. 5·6).
20. 19h. 0m. Venus at maximum brilliancy.
Mar. 21. 1h. 0m. Sun enters Aries. Spring commences.
21. Saturn. Outer minor axis of outer ring = 13″·75.
22. 11h. 19m. to 12h. 24m. Moon occults p^5 Leonis (mag. 5·5).
28. 13h. 41m. to 15h. 0m. Moon occults ν Scorpii (mag. 4·5).
29. 13h. Mars in conjunction with sun.

OBSERVATIONS OF 900 DOUBLE AND MULTIPLE STARS.—The first of the astronomical series of publications from the University of Pennsylvania consists of the measures of 900 double and multiple stars made by Prof. Doolittle with the 18-inch refractor of the Flower Observatory. These observations were made during the period 1897 January 1 and 1900 October 15. In all cases a power of 592 diameters was employed. Twenty-two of the stars are now catalogued for the first time, having been discovered during the observation of neighbouring doubles.

The 18-inch objective is the largest lens made by Brashear up to the present time, and has given every satisfaction, both as to resolving and light-grasping power. The mounting, by Warner and Swasey, is of similar construction to the Lick and Yerkes instruments (*Publications of the University of Pennsylvania, Astronomical Series*, vol. i. part iii.)

OBSERVATIONS OF 194 DOUBLE STARS.—*Bulletin* No. 11 from the Lick Observatory contains a list of observations made by Mr. R. G. Aitken during 1900 and 1901 with the 36-inch and 12-inch refractors. Many of the stars are difficult pairs, and in most cases the 36-inch telescope was employed, with powers ranging from 1000–2400.

RADIO-ACTIVITY AND THE ELECTRON THEORY.[1]

ELECTRONS emanating from radio-active bodies behave like material particles, and are impeded by the molecules of the surrounding medium, in contrast with ether waves, which are not thus affected except by absorption. It is not difficult to put these indications to test. A pair of shallow cells, A B (Fig. 1), 1·5 mm. deep and 25 mm. square, were made by cementing slips of glass to a thick glass plate. The cells were filled to the same depth with a radio-active substance chiefly containing actinium.[2] Over cell A was placed a piece of thick lead pipe, 28 mm. high and 25 mm. internal diameter, to ensure that any emanations from the active substance in A would be confined to the inside of the hollow cylinder. The radio-active substance in B was freely exposed to the air, save for a pillar of lead at C, to support the sensitive film. A sensitive film was laid horizontally over the cylinder and support C. On the film was a plate of glass, and cylinder and film were pressed together by heavy weights. The whole was covered in a light-tight box and put in a dark cupboard.

At the end of forty-eight hours the film was removed and developed. There was a strong action shown over cell A (the one covered by the lead cylinder), but over B, the cell exposed to the air, there was no visible impression. Measured in Mr. Chapman Jones's "Opacity Meter"[3] the results were:—

Image over cylinder—Opacity log.[4] = ·79; Opacity[5] = 6·17.

The experiment was repeated, using the same apparatus, but a different preparation of actinium. In this case the exposure was for seventy-two hours. As before, there was a strong impression over cell A and none over cell B. The figures were:—

Opacity log. = ·89; Opacity = 7·71.

These experiments indicate that the electrons from the radio-active agent, chiefly actinium, partake of the properties of a fog or mist of material particles, capable of diffusing away in the free air like odoriferous particles, when not kept in by a thick metal screen.

A further experiment was now tried with the same apparatus, the agent a strongly active radium and barium bromide. This material being self-luminous, a sheet of black paper was placed

1 By Sir William Crookes, F.R.S. A Paper read before the Royal Society on February 6.
2 The body I called Uranium X in my Royal Society paper, May 10, 1900, has since proved to be M. Debierne's Actinium.
3 *The Photographic Journal*, vol. xx. p. 86, December 21, 1895.
4 The opacity logarithm represents the density of the image, absolute density being represented by 2·00.
5 The "opacity" is the whole number corresponding to the "opacity log." The "opacity" is directly proportional to the photographic energy acting on the sensitive surface.

immediately over it, so that nothing but emanations capable of passing through the opaque paper would be subject to experiment. Afrer four hours' exposure in total darkness, the film was developed. A good circular patch was obtained over cell A, and a faint diffused darkening showed over the rest of the film, darker at the spot immediately over cell B, fading away at the sides as the distance became greater. That this action was due to the material in the open cell B, and not to general fog over the plate, was seen by the clearness of the film where covered by the lead, and where shadows were thrown by the lead cylinder and pillar.

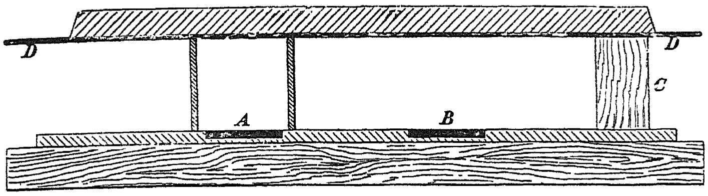

Fig. 1—Elevation.

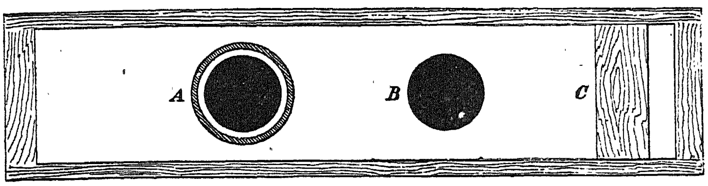

Fig. 1.—Plan.

Circles of the same diameter were drawn round the dark impression over A, and round the darkest part of the impression over cell B. Measurements were taken of different parts of the spaces enclosed in these circles, and the mean of all these came out—

Circle over cell A—Opacity log. = ·53; Opacity = 3·39.
Circle over cell B—Opacity log. = ·32; Opacity = 2·09.
Ratio B/A = ·62.

The experiment was repeated, with the addition of a sheet of aluminium, 0·2 mm. thick, under the black paper, the electrons now having to pass through both paper and metal before reaching the film.

The exposure was for six hours, and the appearance on development was very similar to the last: a dark disc over the protected cell A, and a diffused action over the other part of the film, except in the shadow of the lead supports. Measurements as on the previous occasion gave the following results:—

Circle over cell A—Opacity log. = ·78;
Opacity = 6·03.
Circle over cell B—Opacity log. = ·48;
Opacity = 3·02.
Ratio B/A = ·5.

Finally, I tried polonium subnitrate, which gives off emanations hardly capable of passing through any screen, and greatly obstructed by a few centimetres of air.

The apparatus was substantially the same as the one just described, with the modification that the lead cylinder was 12 mm. high, and at the other end a rod of glass 12 mm. high was used to support the film. The reduced height was chosen, experience showing that polonium emanations have great difficulty in penetrating many millimetres through air. The exposure was seven days, at the end of which time the film was developed. Over cell A a dark disc sharply defined the inside of the cylinder, while over cell B was a hazy diffused patch which to the eye looked much the fainter of the two. But measurements of patch A, and of a disc over cell B of the same size as A, showed that the opacities in each case were practically identical, as shown by the following figures:—

Circle over cell A—Opacity log. = ·74; Opacity = 5·49.
Circle over cell B—Opacity log. = ·76; Opacity = 5·75.
Ratio B/A = 1·05.

A repetition of the experiment, taking the mean of five concordant results, gave the same opacities as before.

Without proving that the emanations from polonium are less material than those from actinium and radium, this experiment shows that their behaviour is entirely different as regards diffusibility through air. Whether this is due to the larger mass of the individual particles, or to the less distance they have to travel (12 mm. as against 28 mm. in the case of actinium and radium), or to some other cause, further experiments must decide.

Dr. Rutherford shows that air which has remained for some time in the neighbourhood of thoria and then is carried in a current to a distance retains its property of communicating radio-activity to other bodies. He explains these phenomena by supposing that thoria gives off a special kind of emanation capable of being conveyed by the air, and that this is the cause of the induced radio-activity.

To ascertain if the electrons or corpuscles from radium also possess the property of being carried along in a current of air I fitted up an apparatus shown in Fig. 2. A, B, and C are three brass tubes closed at the lower end and cemented with paraffin to a wooden block. The upper ends were accurately ground to a level surface and then coated with a thin layer of paraffin wax. Holes were drilled in B and C, to admit glass tubes, cemented air-tight into the cylinders, as shown in the figure. The upper end of the tube in B was closed with a plug of cotton-wool, and the outer end in C was connected to a water-pump, so that when the cylinders were closed at the top a current of air was drawn through B and C. As the radium compound was self-luminous, discs of thin aluminium foil were placed over cylinders A and B to cut off the luminous rays. A sensitive film was laid on the three cylinders over the aluminium, and it was tightly pressed down by a heavy weight, the contact between the film and the tops of the cylinders being sufficient to make the whole air tight. At the bottom of A and B a radium compound was placed, equal weights and equal surface in each. The whole

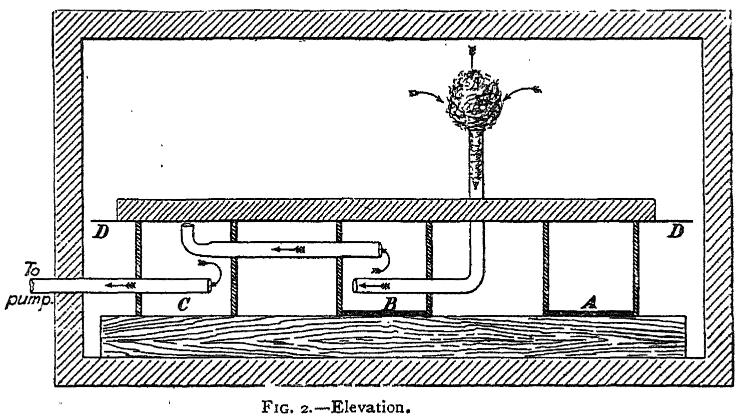

FIG. 2.—Elevation.

was put into a light-tight box, and air drawn through. The cylinder A was used only as a standard. The air passing into B was expected to carry along with it some of the corpuscles emitted from the active material at the bottom; and the inlet tube in C was turned up at the end, so that the stream of corpuscles-laden air should impinge on the surface of the centre of the film on C, and if it carried with it any radio-active properties the result should be seen on development, by the production of a dark patch. If, however, the air carried no corpuscles, there would be no image on the sensitive film over C.

The experiment was continued for eleven hours, 120 litres of air having passed through in the time.

On development and measuring the resulting images, the following figures were obtained :—

Circle over cell A—Opacity log. = ·342 ; Opacity = 2·20.
Circle over cell B—Opacity log. = ·178 ; Opacity = 1·51.
Circle over cell C—Opacity log. = ·025 ; Opacity = ·11.
Ratio B/A = ·68.

It thus appears that a current of air passed over the surface of a radium compound carries with it a certain proportion of the corpuscles. This is proved by the diminished photographic action in the second cell, slightly confirmed by the evidence that some few of the corpuscles so carried away get to the sensitive film on cell C. Judging from our slender knowledge of the properties of free electrons, it is highly probable that they will not easily turn a corner, but cling to the sides of the tube through which they are being led. On the other hand, the constant collisions with the atoms of air may reduce their initial mobility almost to a vanishing point before they have travelled along the tube between B and C, and then they would be carried along with the air.

The experiment was repeated, using a preparation of actinium (Uranium X). It was kept going for seventy-two hours, during which time 750 litres of air were drawn through the apparatus. On development and measurement, the following results were obtained :—

Circle over cell A—Opacity log. = ·99 ; Opacity = 9·78.
Circle over cell B—Opacity log. = ·67 ; Opacity = 4·68.
Circle over cell C—Opacity log. = ·25 ; Opacity = 1·78.

Here then the results agree with those tried with radium compounds ; that corpuscles are carried by a current of air from cell B, through the connecting tube to cell C. They also confirm those of Dr. Rutherford—who finds that thorium emanations travel in a current of air while retaining their activity—and of P. Curie and A. Debierne, who show that induced radio-activity can be transmitted through capillary tubes, of an internal diameter of ·1 mm. and 75 cm. in length, bent once at right angles.

I have not obtained, however, a similar result with the emanations from hydrogen peroxide. As shown by Dr. Russell, this substance has a strong action on a sensitive photographic plate. The emanation from a bottle half full of hydrogen peroxide acts strongly on a sensitive film laid over the open mouth of the bottle for twenty-four hours, while there is no action in seventy-two hours if a U-shaped tube passed through the cork of the bottle and the sensitive film is put close to the open end of the tube. Dr. Russell tells me his observations confirm my experiments.

A highly active self-luminous radium compound loses some of its power on long exposure to the ordinary air of the laboratory. When enclosed in glass, the glass soon assumes a pink colour. If, however, the radium compound is sealed in vacuo in a *quartz* tube, no coloration takes place, and I can detect no diminution of energy even in twelve months.

Electrons from radium will pass through aluminium and a considerable length of air and affect a sensitive film.[1] Experiments on this point were tried with polonium, and it was found that air offered great obstruction.

The electron theory explains a fact which has long puzzled experimentalists. It is well known that if a coin is laid on a sensitive plate in perfect darkness and connected with one pole of an induction coil for a few seconds and then developed, an image can be obtained of the raised parts of the coin. This has generally been explained by saying that the electrified stream of air, or the "brush discharge," affects the film like light.

But Mr. F. Sanford (NATURE, vol. lv. p. 485) shows that coins embedded in the centre of a block of paraffin 2 cm. thick, where they could not send off streams of electrified air, can still be photographed by means of the induction coil. In these circumstances it is probable that electrons are the agents, as electrons will easily pass through paraffin wax from the coin to the sensitive plate, when the coin is connected with the negative pole of an induction coil, the other pole being connected with a metal plate placed below the wax block.

[1] Using an active compound of radium, I have obtained an impression on a sensitive film, through a penny-piece.

Hitherto we have been dealing with negative electrons—a free positive electron at present is unknown. In a paper communicated to the Royal Society, December, 1890 (*Phil. Trans.*, 1901, A, vol. cxcvi. p. 525), the Hon. R. J. Strutt offers a suggestion as to positive ions which in a satisfactory manner appears to explain much that hitherto has been left doubtful, not to say contradictory.

He adopts the generally recognised theory that the deflectable Becquerel rays consist of a stream of negative corpuscles with enormous velocities proceeding from the radio-active body. But there are two kinds of Becquerel rays, one deflectable and penetrating, the other non-deflectable and easily absorbable. Mr. Strutt considers that these non-deflectable rays are positive ions moving in a stream from the radio-active body.

He says :—"We know that the positive ions in gases carry the same charge as the negative, and that they have an enormously greater mass. Unless, therefore, their velocity is smaller out of all proportion than the negative ions, it is to be expected that they will be much less easily deflected by the magnet. . . . Next it may be noticed that the smaller penetrating power would be well accounted for by the size of the positive ions, which would, of course, make more collisions with the molecules of the surrounding gas than the much smaller negative ions."

Of the three radio-active bodies, radium, actinium and polonium, actinium appears to emit corpuscles almost entirely of the penetrating, deflectable kind, polonium rays of the non-deflectable, non-penetrating kind, whilst radium emits rays of both kinds.

On the above hypothesis, corpuscles from polonium might consist of the heavy positive ions: to test the accuracy of this inference experiments are now in progress.

Some curious and far-reaching inferences may be drawn from Mr. Strutt's view, supposing it to be correct, that positive as well as negative corpuscles will fly off from a radio-active body. In a paper "On Electrical Evaporation" (*Roy. Soc. Proc.*, vol. l. p. 88, June, 1891) I showed that many bodies, such as silver, gold, platinum, &c., usually considered non-volatile at ordinary temperatures, easily volatilise in a vacuum if connected with the negative pole of an induction coil, remaining fixed when connected with the positive pole. This phenomenon was first observed by Dr. Wright, of Yale College, and was applied by him for the production of mirrors for physical apparatus. It is shown by experiments that the action in the vacuum tube is of two kinds. A silver pole was used, and near it, in front, was a sheet of mica with a hole in its centre. The vacuum was very high (P = 0·00068 mm.), and when the poles were connected with the coil, the silver being negative, electrons shot from it in all directions, and passing through the hole in the mica screen, formed a bright phosphorescent patch on the opposite side of the bulb. The action of the coil was continued for some hours, to volatilise a certain portion of the silver. On subsequent examination it was found that silver had been deposited only on the mica screen and in the immediate neighbourhood of the pole, the far end of the bulb, at the spot which had been glowing for hours from the impact of electrons, being free from silver deposit. Here then are two simultaneous actions. Electrons, or, as I once called them, "radiant matter," shot from the negative pole and caused the glass against which they struck to glow with phosphorescent light. Simultaneously the heavy positive ions of silver, freed from their negative electrons, or under the influence of the electrical stress, likewise flew off, and were deposited in the metallic state near the pole.

During the course of my experiments a curious circumstance was observed, which deserves record as it may elucidate some of these obscure phenomena. While the volatilisation of the silver pole is rapidly proceeding, the metal glows as if red-hot. This "red heat" is superficial only. The metal instantly assumes, or loses, the appearance of red-heat the moment the current is turned on or off, showing that the high temperature does not penetrate below the surface. The volatilisation of the positive ions is confined to the surface and the surface glow is connected with that action. If instead of silver, a good conductor of heat, I take diamond, a bad conductor, the surface layers are changed sufficiently to convert them into a form of graphite, which from its great resistance to oxidising agents cannot have been formed at a lower temperature than 3600° C.

THE MILROY LECTURES ON TYPHOID FEVER.

PROF. CORFIELD gave the first of his course of Milroy Lectures on typhoid fever at the Royal College of Physicians on Thursday last.

After an introduction, in which he defended the name typhoid fever as that used by Louis and Jenner, and as being the least objectionable name to give to the disease, and pointing out that the name of enteric fever is a bad one, not only because it gives the name to a general disease from a particular lesion, but because it suggests the false idea that the disease is due to that lesion, he proceeded to give a short history of the subject from the beginning of the last century, first introducing a hitherto unknown author, Dr. Christopher Mayr, of Vienna, an unopened copy of whose Latin work on fevers, published in Vienna in 1806, he had found in the library of the Royal Medical and Chirurgical Society of London. He stated that there is no other copy of this book known in London, whether in the British Museum or anywhere else, and that the leaves had not been separated when he found it. This author gives an admirable classification of fevers into genera and species, the different varieties of typhus forming his second genus, and including typhus fever and the oriental plague, which were confused together until long after that time, the occidental plague or American yellow fever, all of which he regarded as contagious, and three varieties which he regarded as non-contagious and which were evidently, from his excellent description, varieties of typhoid fever.

This author also gave a most interesting disquisition on the contagion and on the causes of these diseases. It is remarkable also to note that he includes phthisis pulmonalis among the fevers, though he does not say whether he regards it as contagious or not.

Dr. Corfield then gave an account of the work and views of MM. Louis, Chomel, Gaultier de Clanbry, Montault, Rochoux, and other French physicians, some of whom considered typhus and typhoid as the same disease and others as different diseases.

After alluding to the work of a number of other investigators, especially Dr. Lombard, of Geneva, and Dr. Shuttuck, of Boston, he gave an account of an important paper, read by Dr H. C. Barlow before the Parisian Medical Society on February 6, 1840, on the distinction between typhus and typhoid fevers. In this paper Dr. Barlow described the differences between the two diseases, and decided positively that they were quite distinct from one another.

Two months after this, Dr. Alexander P. Stewart also read a paper on the same subject before the Parisian Medical Society, but, contrary to the opinion generally held, he did not advance the knowledge of the subject in any way by his paper, and, in fact, did not lead us as far as Dr. Barlow had already done.

The work of Prof. Forget, of Paris, on follicular enteritis (even a worse name for the disease than enteric fever) was next alluded to, it being quite clear that Prof. Forget thoroughly understood what typhoid fever was and that it was a different disease from typhus.

Such was the position when Dr. William Jenner (afterwards Sir William Jenner, Bart., G.C.B., president of the Royal College of Physicians) undertook the investigation of the question. As he had been resident medical officer of the London Fever Hospital, he had had an excellent opportunity, of which he made the best use, of observing cases, both of typhus and typhoid fevers, and in 1849 he published his admirable paper on the identity or non-identity of those diseases. He proved to a demonstration that they were different diseases, and in a subsequent paper also proved that without a doubt their causes were different.

It was reserved, however, for Dr. Charles Murchison, in his able paper read before the Royal Medical and Chirurgical Society of London in 1858, to demonstrate that typhoid fever is caused in some way or other by water, air and soil contaminated with foul organic matters. In his great treatise on the continued fevers of Great Britain, he maintained that the poisons of those diseases were generated *de novo*; that of typhoid fever from decomposing excrement.

In 1873, Dr. William Budd produced his masterly work on the disease, proving that "typhoid fever is in its essence a contagious or self-propagating fever."

Dr. Corfield finally quoted from his own paper, "On the alleged Spontaneous Production of the Poison of Enteric Fever," read before the Epidemiological Society in March, 1874, when he combated the views of Dr. Murchison and maintained that the disease was infectious and had a special poison, which was not generated *de novo*, but was always derived from a previous case of typhoid fever. The correctness of this view has now been established by the discovery of the organism peculiar to the disease.

VESSELS WITH TURBINE MACHINERY.

THE introduction of the Parsons marine steam turbine into practice has extended ever since the time the *Turbinia* showed her marvellous qualities for speed, and was followed by the two torpedo boat destroyers, H.M.S. *Viper* and H.M.S. *Cobra*, which broke all previous records with a speed above 35 knots. The next steamer thus equipped was the *King Edward*, an excursion steamer plying on the Fairlie-Campbeltown route, and being the pioneer vessel belonging to the mercantile marine fitted with turbines, created a considerable interest at the time. The *King Edward* has now undergone a season's running, and (says *Engineering*, January 24) in order thoroughly to test her turbine machinery and coal consumption, data have been tabulated from her and also from the Clyde passenger paddle steamer of the same size named *The Duchess of Hamilton*, thus giving a comparative statement of the two vessels for the "running" throughout the season. The table is as follows:—

Comparative Statement of Speed, Mileage and Coal Consumption of the Paddle Steamer "Duchess of Hamilton" and the S.S. "King Edward."

	Duchess of Hamilton.	*King Edward.*
Total coal	1758 tons 13 cwt.	1429 tons 16 cwt.
Miles run	15,604	12,116
,, per ton...	8·87	8·47
Number of days running ...	111	79
Daily average consumption..	15 tons 17 cwt.	18 tons 2 cwt.
Average speed	about 16½ knots	about 18½ knots

On referring to the above table, it will be seen that the figures of coal consumption per mile are satisfactory, and also the data prove a decided victory for the steam turbine over the reciprocating engines, insomuch as although the *King Edward* is by far the faster boat, her consumption of coal per mile is almost as low as that of the *Duchess of Hamilton*. In a previous issue we pointed out that one of the chief advantages gained by the adoption of the turbine was the possible modification in the "model" of the boat, as finer lines could be introduced for speed purposes. The *King Edward* in this respect also, we understand, has given entire satisfaction to her owners, and not unnaturally another boat of the same type, but 21 feet longer and with a speed of 21 knots, is being built, the Parsons Marine Steam Turbine Co. being at present engaged on the machinery.

It is also worthy of notice that the class of craft being built with turbine machinery at the present time comprise three high-speed yachts of large size, one being of the torpedo-boat type with water-tube boilers, so, as is pointed out, the turbines will have every opportunity of appearing at their best. The Parsons Company have also a torpedo-boat destroyer with a similar speed to the *Viper* (not being built to the order of the Admiralty) which we are informed will have a less consumption both in cruising and full speed than any other 30-knot boat in the Navy.

This vessel, which is named the *Velox*, was launched by her builders (hull and boilers), Messrs. R. W. Hawthorn, Leslie and Co., on the Tyne on February 11, and measures 210 ft. long, 21 ft. beam, with a moulded depth of 12 ft. 6 in., and to guard against "buckling" she has been specially "stayed" longitudinally. The *Velox*, to ensure economy at cruising speeds, has fitted in her a novel arrangement of power wherein engines of the ordinary reciprocating type are designed to work in conjunction with, and are coupled direct on to, the steam turbines, the turbines being kept in reserve for the higher speeds only. In considering coal consumption, it will be seen at once that the engine arrangement introduced by Mr. Parsons forms a very important item, because, as in the case of torpedo-boat destroyers, but a small percentage of their steaming is spent on full speed work; and also, as is well known, as all steam engines (steam

turbines included) do not work so economically when running much below the power for which they are designed. For the long periods on which these boats are simply cruising about, the coal consumed is only that of the two small triple compound reciprocating engines, the steam turbines not being utilised, thus reducing their "cruising" coal consumption to a minimum which, when running at full speed, is only increased by the low consumption derived from the use of the steam turbine.

The marine steam turbine, forming, as it does, "one of the most striking developments in the history of marine engineering," is largely adopted by private enterprise; but, as *Engineering* points out, "it is a little surprising that at present no vessel is in progress fitted with turbine machinery and built for the Royal Navy."

MECHANICAL VENTILATORS FOR MINES.[1]

THIS report is the outcome of a large number of experiments conducted under the directions of a strong committee of eminent mining engineers. Its object was to obtain exact information concerning the relative efficiencies of various ventilating fans. In order to make the comparisons of real value, the experiments were restricted to collieries provided with two fans, each of which could be used in turn; the conditions were therefore identical in each case. Only three kinds of fans were compared, viz., the Guibal, the Schiele and the Waddle, with the result that the Guibal decidedly carried off the palm. But, as pointed out in the report, the conclusions arrived at are not beyond criticism, because the efficiencies were determined in each case by taking the ratio between the so-called "useful effect in air" and the indicated horse-power of the steam-engine used for driving the fan, without knowing how much power was consumed in overcoming the inherent resistance of the engine. Some experiments made in Belgium in 1899 were more satisfactory, because this point was taken into consideration. Here it was found that the Rateau fan had a decidedly higher mechanical efficiency than the Guibal.

The Committee has adhered to Murgue's time-honoured method of comparing the resistance of any given mine to that of an orifice in a thin plate. No doubt the idea of an imaginary "equivalent orifice" has served a useful purpose, but a simpler and plainer way of expressing the amount of resistance is that advocated by Hanarte; he reckons the resistance of a mine by the horse-power required to overcome it, and there is much to be said in favour of his proposal to classify mines according to this system.

Long pages crowded with figures bear testimony to the pains taken by the Committee to fulfil its task, and it is interesting to find that its observations afford a verification of the two fundamental formulæ of centrifugal ventilators. Mr. Walton Brown, the indefatigable secretary of the Institution of Mining Engineers, may be fairly congratulated upon the useful report which he has drawn up.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

OXFORD.—The 233rd meeting of the Junior Scientific Club was held on February 21. Dr. Hedin, of the Jenner Institute of Preventive Medicine, read a paper, chiefly an account of his recent researches, on "The Proteolytic Enzymes of the Animal Body."

MR. T. P. KENT, scholar of Christ Church, Oxford, and assistant master at Cranleigh School, Surrey, has been appointed professor of mathematics at Rondebosch College, Cape Town.

IN view of the date appointed for the coronation of their Majesties, the day examinations of the Board of Education, South Kensington, arranged to be held during the week ending June 28, will be held during the week ending July 5.

AN article on the use of ordnance survey maps in teaching geography, contributed by Sir Archibald Geikie to the February number of the *Geographical Teacher*, directs attention to the invaluable aid to the study of geography which these maps afford. In spite of the fact that the maps are adapted to instruction in the most elementary or the most advanced stages of geography, and are so cheap, they are but rarely used, and the geographical lesson is usually conducted in the unintelligent way with which we are all familiar. Hung upon the wall of the schoolroom, the maps encourage the study of home geography in the pupils, and give them facility in map-reading. Attention may then be directed to the information the maps contain as to the configuration or topographical features of the land, the system of contouring, and the method of plotting profiles or sections across a piece of ground. The teacher can then pass to the intelligent consideration of the causes of the varying physical features of the land, using for this purpose the maps of the Geological Survey, or can derive lessons on the influence of physical features upon the history and progress of the inhabitants of a country. Many other similar uses can be made of the maps, and by adopting them geography may be made a scientific study instead of a jumble of words, figures and phrases. It is to be hoped that Sir Archibald Geikie's paper will be read by every teacher who desires to make the geography lesson a means of cultivating the intelligence. Another paper in the *Geographical Teacher* which will assist this object is by Mr. A. M. Davies, on the geography of Greater London. Mr. James Bryce's address on the importance of geography in education, delivered at the recent annual meeting of the Geographical Association and already noticed (p. 284), appears in the same number of the magazine.

A REPORT of the discussion on reform in the teaching of mathematics, which took place at the meeting of the Mathematical Association on January 18, is published in the *Mathematical Gazette*. Prof. A. Lodge opened the discussion with a paper in which he advocated the introduction of a course of geometry similar to that taken in French schools. The chief points in the French text-books which he desired to see introduced are:—(1) The more orderly arrangement of propositions; (2) the entire separation of theorems from problems of construction, hypothetical constructions being used in proving a theorem; (3) the closer association of a proposition and its converse when both are true; (4) the adoption of arithmetical notions and algebraic processes; (5) the early introduction of simple loci; (6) insistence on accurate figures drawn by accurate and practical processes; (7) practice in exercises from the very beginning. In the subsequent discussion, Prof. G. M. Minchin, F.R.S., gave instances of the failure of boys to understand Euclid's language and methods, and also described desirable reforms in the teaching and nomenclature of dynamics and hydrostatics. The discussion was, however, mainly concerned with the teaching of geometry, and the general opinion of the speakers was that demonstrative geometry should be preceded by a course of work with ruler, compasses and protractor, in which simple measurements and constructions formed the chief part. This has been done for many years in Scottish schools and also in some elementary schools in England. One speaker expressed his surprise at the amount of work that could be done with a pencil, ruler, a pair of scissors and a piece of paper, and others referred to the value of illustrations of geometrical truths obtained with similar materials. It seems, however, to have been overlooked that this work has long been part of kindergarten teaching.

SCIENTIFIC SERIAL.

American Journal of Science, February.—On geometric sequences of the coronas of cloudy condensation, and on the contrast of axial and coronal colours, by C. Barus.—On a new occurrence of sperrylite, by H. L. Wells and S. L. Penfield. A minute quantity of sperrylite, platinum arsenide, was found in a specimen of platiniferous copper ore from the Rambler Mine, Medicine Bow Mountains. Platinum is found in ores from all parts of the mine in quantities varying from ·06 to 1·4 ounces per ton.—A cosmic cycle, by F. W. Very.—Studies of Eocene mammalia in the Marsh collection, Peabody Museum, by J. L. Wortman. The present instalment deals chiefly with *Patriofelis ferox*, and contains a detailed criticism of the views recently expressed by H. F. Osborn.—On a miniature anemometer for stationary sound-waves, by B. Davis. By sufficiently reducing the dimensions of the cups and vanes in the ordinary anemometer, it was found possible to determine the relation between the amplitude of vibration and the rate of rotation in

[1] Report of the Committee of the North of England Institute of Mining and Mechanical Engineers, and the Midland Institute of Mining, Civil and Mechanical Engineers. By Mrs. M. Walton Brown. *Transactions of the Institution of Mining Engineers* (vol. xvii. pp. 96+xvii plates).

a stopped organ pipe giving its first overtone. The cups used varied in size from 7·5 mm. to 4·5 mm., and the lengths of the arms from 20 mm. to 8 mm. The curves found correspond closely to the sine curves near the middle of the loop where the amplitudes of vibration have considerable magnitude.—The occurrence of fossil remains of mammals in the interior of the states of Pernambuco and Alagoas, Brazil, by J. C. Branner.—The estimation of copper as cuprous sulphocyanide in the presence of tin, antimony, arsenic and bismuth, by R. G. van Name. The accurate estimation of copper in the presence of the above-named metals was found to be practicable provided that certain precautions were taken as to the amount of free acid, ammonium bisulphite and sulphocyanide used.—The composition of yttrialite, with a criticism of the formula assigned to thalenite, by W. F. Hillebrand. The empirical formula of Hidden and Mackintosh for yttrialite is confirmed. The formula proposed by Benedicks for thalenite is to be regarded as doubtful.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Astronomical Society, February 14.—Anniversary Meeting.—Dr. J. W. L. Glaisher, F.R.S., president, in the chair.—The secretaries read the annual report of the council, containing obituary notices of deceased fellows and associates, reports of the work of observatories in Great Britain and Ireland and the Colonies, and notes on the progress of astronomy during the past year.—The president announced that the council had awarded the Society's gold medal to Prof. J. C. Kapteyn, of Groningen, Holland, for his work in connection with the Cape Photographic Durchmusterung and his researches on stellar distribution and parallax. The president delivered an address, setting forth the grounds upon which the award had been made. The address dealt chiefly with Prof. Kapteyn's great work in measuring and reducing the stellar photographs taken at the Royal Observatory, Cape of Good Hope, and in preparing the catalogue, which had been completed and published, forming three volumes of the *Annals* of the Cape Observatory. The actual photographing of the plates was begun by Dr. (now Sir David) Gill in 1886 and finished in 1890. Prof. Kapteyn spontaneously undertook the great work of measurement and reduction and the formation of the catalogue—a labour which occupied him more than twelve years. The catalogue contained 454,875 stars down to about the 9·5 magnitude, from − 18° to the South Pole.—The president presented the gold medal to Prof. Kapteyn.—He also presented the Jackson-Gwilt bronze medal to the Rev. Thos. D. Anderson, for his discoveries of Nova Aurigæ and Nova Persei.

Entomological Society, February 5.—The Rev. Canon Fowler, president, in the chair.—The president announced the appointment of Mr. F. D. Godman, F.R.S., Prof. E. B. Poulton, F.R.S., and Dr. D. Sharp, F.R.S., as vice-presidents for the session.—Prof. Poulton exhibited with lantern a series of slides belonging to Prof. Meldola, made from actual specimens by the three-colour process, illustrative of mimicry in British and exotic Lepidoptera and Hymenoptera. He also exhibited the several specimens from which the lantern slides had been prepared.—Mr. C. G. Barrett exhibited a series of the perfect insect of *Glottula fusca*, Hpsn., together with ears of maize (locally called mealies), showing the damage done by the well-grown larva of the species, which lives in the first place in the stem, eating the pith from the ground, and afterwards attacking the cobs, and eating from the inside into the bases of the unripe grains, which then change colour and shrivel up. He also exhibited specimens and figures to illustrate the life histories of South African Heterocera, received from Miss Frances Barrett, Buntingville, Transkei, South Africa.—Mr. W. L. Distant exhibited two specimens of Coleoptera which he received alive from the Transvaal—one *Anthia thoracica*, Thunb., now dead, the other *Brachycerus granosus*, Gyll., still living. These insects had been sent him by Mr. Robert Service, of Dumfries, who received them from Sergt. Peter Dunn, of the volunteer company of the Scottish Borderers. The genus Anthia extends to the southern Palæarctic region, and there seems little doubt that these species could be easily acclimatised there. All they require at home is the run of a good palm or orchid house.—Mr. R. Adkin exhibited a series of *Acidalia aversata*. The parent moth (a banded female, the male parent not being known) was taken at Lewisham in June, 1900. Of the resulting larvæ, about one-half fed-up rapidly and produced imagines in the autumn of the same year—a very unusual circumstance; the remainder hibernated and produced imagines in June of the following year, thus occupying the normal time in completing their metamorphoses. The proportion of individuals following the female parent in the two portions of the brood was almost equal.—Mr. G. C. Champion exhibited long series of *Leptura stragulata*, Germ., and *Strangalia pubescens*, Fabr., from the pine-forests of Aragon and Castile, showing the great variation in colour of the two species in these districts, whereas the allied forms occurring in the same places, viz. *L. rubra*, Linn., *L. distigma*, Charp., *L. unipunctata*, Fabr. and *L. sanguinolenta*, Linn., were perfectly constant; also *Dermestes aurichalceus*, Küst., which he and Dr. Chapman had found everywhere in abundance in the old nests of the processionary-moth (*Cnethocampa processionea*, Linn.) on the pines in these forests.—Dr. T. A. Chapman exhibited in illustration of his paper, on a new subfamily of Pyralidæ, living larvæ of *Hypotia corticalis*, Schiff, as well as preserved larvæ, pupa-cases, imagines, and prepared wings to show the neuration of that species.—Mr. Edward Meyrick communicated descriptions of new Australasian Lepidoptera.—Mr. W. F. Kirby communicated a Report on a collection of African Locustidæ, chiefly from the Transvaal, made by Mr. W. L. Distant.

Geological Society, February 5.—Mr. J. J. H. Teall, V.P.R.S., president, in the chair.—The matrix of the Suffolk Chalky Boulder-Clay, by the Rev. Edwin Hill. The author has been examining with the microscope washed residues from Boulder-Clays. He is able to group together the specimens from localities along a belt of country from Lowestoft to Bury St. Edmunds, as containing granules of Secondary clays and limestones. Other specimens contain granules which may be the same kind decomposed, others granules of other kinds; all these lie outside the belt occupied by the group, though some are very near it. The results lead to the conclusion that the materials of the matrix in the Suffolk Chalky Boulder-Clay were not brought from the east or north, but from inland, and not from so far inland as the Coalfields. Their sources therefore lie on a limited belt, bordering the Boulder-Clay area.—On the relation of certain breccias to the physical geography of their age, by Prof. T. G. Bonney, F.R.S. The author has endeavoured in this paper to collect from published accounts and his own observations the evidence which certain well-known and important beds of breccia afford as to the physical conditions prevalent when they were formed. Reasons are given for concluding that the Rothliegende (and probably the Triassic) breccias are indicative of a continental climate, due to a great extension of land or more probably the existence of a mountain-region on the west—winters with severe cold and snow, but rather hot and arid summers. The Caithness breccias are perhaps more analogous to the stone-rivers of the Falkland Islands, but they also indicate a rather low temperature; while the Flysch-breccias land us in the following dilemma, namely, that either similar temperatures existed in Switzerland, and that there was also an important highland district, of which no remnant can be found, within a short distance of the breccia-beds, or they must be the product of a range not inferior to the present Alps, which also has completely disappeared, and would be (for reasons given) very difficult to locate. But, even in the latter case, it must be admitted that a temperature if not lower, at any rate not higher than the present, prevailed in central Europe late in the Eocene period.

Zoological Society, February 4.—Prof. G. B. Howes, F.R.S., vice-president, in the chair.—Dr. Chalmers Mitchell read, on behalf of Mr. E. Degen, a paper entitled "Ecdysis, as Morphological Evidence of the original Tetradactyle Feathering of the Bird's Fore-limb, based specially on the Perennial Moult of *Gymnorhina tibicen*." The material on which the paper was based consisted of a large series of specimens of the Gymnorhina obtained at regular intervals throughout the moulting-period, and the author had thus been able to give a very complete account of the perennial replacement of the feathers, avoiding the errors due to observations on the altered habits as produced by captivity. The author showed that the moulting of the wing-feathers took place in definite groups, and indicated a composite origin of the modern feathering.—A communication from Prof. W. Blaxland Benham contained some notes on the osteology of

the short-nosed sperm-whale (*Cogia breviceps*), based on an examination of a specimen which had been washed ashore on the coast of Otago, New Zealand. The soft parts of the same specimen had formed the subject of a paper presented to the Society by the same author in May of last year.—Two additional papers on the results of the "Skeat Expedition" to the Malay Peninsula were read. The first, by Mr. F. F. Laidlaw, gave an account of the dragon-flies (with the exception of Agrioninæ) collected, and a list of all other species that had previously been known from the Peninsula. One new genus, Climacobasis, and twelve new species were described. The second paper, by Mr. W. E. Collinge, contained an account of the collection of non-operculate land and fresh-water mollusca made by the expedition, and included descriptions of three new genera (Apoparmarion, Paraparmarion and Cryptosemelus) and eight new species, besides contributions to the anatomy of certain species. Descriptions of three species of Prisma in the British Museum collection, one of which, *P. smithi*, was new, were also included in the paper.—A communication from Mr. W. F. Kirby contained a list of twenty-three species of Orthoptera, of which specimens were contained in a collection made by Sir Harry Johnston, K.C.B., in the Uganda Protectorate.

Mathematical Society, February 14.—Dr. E. W. Hobson, F.R.S., president, in the chair.—Prof. Lamb read a paper on Boussinesq's problem. The problem is to determine the strain produced at any point of a semi-infinite elastic solid, with a plane boundary, by the application of pressure to its surface; the solution is obtained in a straightforward manner by the use of Bessel's functions.—Mr. A. Young read a paper on quantitative substitutional analysis. This paper is a continuation of a previous one, published in *Proceedings*, vol. xxxiii., in which the conditions that a function of several variables may be unaltered by particular substitutions, belonging to particular groups, were applied to the development of relations between the concomitants of quantics.—Prof. Love explained a new proof of a well-known theorem concerning zonal harmonics.—The following papers were communicated by the president:—Dr. H. F. Baker, elementary proof of a theorem for functions of several variables. The theorem is that, if an ordinary power series in any number of variables does not vanish for zero values of the variables, the inverse of the series can be expanded in a converging series; it is proved also that the range of convergence of the new series is the same as that of the original series, provided that no zero of the latter is contained in this range.—Mr. T. J. I'A. Bromwich, note on the wave surface of a dynamical medium æolotropic in all respects. The kinetic energy of the medium is taken to be a homogeneous quadratic function of the component velocities, and the potential energy is taken to be a similar function of the components of strain and rotation; the equations of motion are deduced from the Hamiltonian principle, and the form of the general wave surface is obtained without having recourse to the methods of vector-analysis.—Prof. A. C. Dixon, on plane cubics. This note contains some further developments of the theory of corresponding points on a cubic, as given by Salmon, and the closely connected theory of three conics.—Mr. W. H. Young, (1) on the density of linear sets of points, (2) on closed sets of points defined as the limit of a sequence of sets of points. The first paper deals with the distinction between sets of points which are everywhere dense and sets which have the property that every point is a limiting point on both sides; the distinction is of great importance in the application of the theory of sets of points to questions concerning functions of real variables; illustrative examples are given. The second paper deals with the geometrical connection between a set of given rank, in a countably infinite number of closed sets, and the corresponding limiting set; the relation between the content of each set of the countably infinite number and the content of the limiting set is discussed in detail.

Royal Meteorological Society, February 19.—Mr. W. H. Dines, president, in the chair.—Mr. E. Mawley submitted his report on the phenological observations for the year 1901. He showed that as affecting vegetation the weather was chiefly remarkable for the scanty rainfall during the growing period of the year. The deficiency was not confined to any part of the British Isles, but was more keenly felt in the English counties than in either Scotland or Ireland. Wild plants came into flower very late, but not quite as late as in the previous phenological year, which was an exceptionally backward one. The swallow, cuckoo and other spring migrants were, as a rule, rather behind their usual dates in reaching these islands. The crops of wheat, barley and oats were all more or less above average in Scotland and Ireland. On the other hand, in England, although there was a fair yield of wheat, that of barley and oats was very deficient. Hay proved everywhere a small crop, and especially so in the southern districts of England. Beans, peas, turnips, swedes, mangolds and potatoes were all more or less under average in England, but either good or fairly good elsewhere. The yield of hops proved singularly abundant. Apples, pears and plums were below average, especially apples, but the small fruits, as a rule, yielded well. Taking farm and garden crops together, seldom has there been a less bountiful year.

MANCHESTER.

Literary and Philosophical Society, February 4.—Mr. Charles Bailey, president, in the chair.—Mr. J. E. King read the first part of a paper on folklore of the North American Indians, from the Jesuit relations (1611 to 1637). Without attempting to give any complete account of Indian culture, the paper described and illustrated particular practices observed by the Jesuits. The savages believed in two main sources of disease, viz., desires in the mind of the patient, or evil practices of an enemy working by witchcraft. The sorcerers, or medicine men, claimed to cure disease and also to produce it, when desired, by practices which come under the head of sympathetic magic. Great importance was attached by the Indians to dreams, singing, dancing and feasting. Wherever these practices had a magical meaning, they were forbidden by the Jesuits to their converts.—The animistic theory of nature is illustrated by the observances with regard to the bones of animals eaten at feasts, the treatment of fishing nets, and offerings to dangerous rocks and rapids. The life of the human soul after death was a shadow of the life on earth. The ghost of the dead was driven from the abode of the living, and the name of the dead was not to be mentioned.—Mr. W. E. Hoyle exhibited two carved wooden bowls from British Columbia, and referred to the skill shown by the Indians in retaining in their carvings the special characteristics of the various animals represented, illustrating his remarks by a series of lantern slides.—Mr. Francis Nicholson drew attention to a paragraph in Mr. Elijah Helm's "Chapters in the History of the Manchester Chamber of Commerce," wherein it is stated that as early as the first half of the seventeenth century cotton was brought from Cyprus and Smyrna to London and thence to Lancashire, where it was spun by hand on the single spindle frame. Mr. Nicholson pointed out that most of the cotton used in Lancashire at that time probably came from the West Indies, and, as confirming this, he read a letter written from London by his great-grandfather, Robert Nicholson, to his brother, James, in Liverpool in 1749, where he quotes: "Jamaica cotton is sold at 16*d.* per lb., some of the very choicest 16½*d.* per lb., Leeward Islands 14*d.* per lb."

CAMBRIDGE.

Philosophical Society, February 3.—Prof. Macalister, president, in the chair.—Oxidation in presence of iron, by Mr. H. J. H. Fenton. The remarkable influence which is exerted by traces of iron in determining and regulating the oxidation of various organic substances was first observed by the author about twenty years ago, and the observation has since opened up a very wide and fruitful field for investigation. The work is still being extended in several directions, and in the present communication a brief summary is given of the principal researches on the subject already published, and of new results which have recently been obtained. The conditions of this oxidation-method show some very close analogies with certain natural processes, and many experiments are in progress with a view of throwing further light upon the function of the iron.—Decomposition of hydrogen peroxide by light, by Mr. R. F. D'Arcy. The author gave an account of experiments showing:—(*a*) That dilute solutions of hydrogen peroxide are rapidly affected by exposure to sunshine. Experiments were chiefly made with aqueous solutions containing 4 per cent. of "20 vol." H_2O_2. Exposure of such a solution in a flask to the sunshine of five days in June resulted in the decomposition of about three-quarters of the hydrogen peroxide. In open dishes it is more rapidly decomposed, and the effect in this case is not dependent, at any rate to any considerable extent, on the evaporation taking place simultaneously. The effect is not a temperature effect. This property of hydrogen peroxide may possibly be of some importance in some of its reactions. (*b*)

That the surface of a solution of hydrogen peroxide undergoing this decomposition is capable of discharging negative electrification. (*c*) That days on which sunlight decomposes hydrogen peroxide most rapidly are the days on which the discharging action is most pronounced. The author draws from these experiments the conclusion that the decomposition of hydrogen peroxide by light is a possible source of production of positive and negative ions in the atmosphere. A detailed account is to be found in the *Phil. Mag.*, January.—Note on a method for determining the concentration of hydrogen ions in solution, by Mr. H. O. Jones and Mr. O. W. Richardson. The investigation described was suggested by a series of observations by Mr. Fenton and one of the authors. They showed that oxal-acetic hydrazone decomposed in presence of water at 100° C. into pyruvic hydrazone and carbon dioxide; but that in the presence of hydrogen ions in sufficient concentration the products were pyrazolone carboxylic acid and water. It was suggested that these reactions might be explained by supposing that the negative ion lost carbon dioxide on heating; whereas the undissociated molecule lost water. Hence the presence of hydrogen ions by diminishing the concentration of the negative ion would diminish the amount of carbon dioxide produced. The experiments here described were undertaken with the view of testing quantitatively the validity of the above hypothesis and the value of the method for determining the concentration of the hydrogen ions in a solution. The authors find that, in the case where the ionisation due to the hydrazone itself is negligible compared with that of the acid used, the experimental results agree with the theoretical conclusions.—The formation of dinitrophenoxazines, by Mr. J. C. Crocker.—When picryl chloride reacts with orthoxyamido-compounds in the presence of alkali, hydrochloric acid and nitrous acid are eliminated, and condensation takes place to a dinitrophenoxazine. Eikonogen, for instance, gave naphthodinitrophenoxazine sodium sulphonate, which consists of minute bronze plates soluble in water.—The interaction of thiocyanates, picryl chloride and alcohols, by Mr. J. C. Crocker. When picryl chloride acts on thiocyanate in absolute alcohol solution, a yellow crystalline body is obtained. It melts at 138°, contains an ethoxy-group, two picryl groups and a sulphur atom. On hydrolysis it gives picramide. Hydrochloric acid is set free in the reaction.—Oxidation of glucosone to trioxybutyric acid, by Mr. R. S. Morrell. Glucosone, prepared from glucose by the action of hydrogen peroxide in the presence of ferrous sulphate, on oxidation with bromine in aqueous solution yielded trioxybutyric acid. The identity of the trioxybutyric acid was established by comparing its calcium and lead salts with those obtained from the trioxybutyric acid which is formed when erythrite is oxidised by nitric acid, also by the reduction of the calcium salt by hydriodic acid and phosphorus to normal butyric acid.—Note on the reduction of a ternary quantic to a symmetrical determinant, by Dr. A. C. Dixon.

Edinburgh.

Royal Society, January 20.—Lord Kelvin in the chair.—Lord Kelvin, in a paper on the specification of stress and strain in the mathematical theory of elasticity, showed how a perfectly symmetrical system applicable to all kinds of strains and not merely to very small strains could be developed by considering the elongations of the edges of a tetrahedron and the related stresses (see *Phil. Mag.* for January, 1902). The method for bringing this system into relation with the ordinary system for infinitesimal strains was indicated, and the discussion was greatly facilitated by the use of models.—Dr. W. Brodie Brodie read a paper on the condition of the iron in the spleen, and detailed some of the results of an investigation into the histological and chemical position of the iron in this organ. By the use of microchemical methods, the metal was found contained in cells and also in bodies not of a cellular nature. Three varieties of iron-containing elements were described as belonging to the latter class. Three proteid bodies containing iron which had been obtained by means of purely chemical methods were also described.—Lord Kelvin communicated a paper on the molecular dynamics of a crystal, discussing in particular (*a*) stable and unstable homogeneous assemblages, (*b*) deviation from homogeneousness in surface layers, (*c*) tensile strength, (*d*) cleavage. The whole discussion was based upon the Boscovich view that the action between neighbouring atoms is attractive or repulsive according to their distance apart. The forces acting upon a given atom will depend, not only upon the nearest neighbours, but also upon those at greater distances. Taking simple configurations, Lord Kelvin showed how during the condensation of an assemblage of atoms configurations of instability might arise, and how the group originally monatomic might either assume a new stable configuration of different density or break up into a diatomic configuration of greater stability. By a process of successive approximations, the final positions of the end particles of a one-dimensional row of particles acting on one another, according to an assumed Boscovichian law, were calculated. Reckoning from the end, the distances between the successive pairs of contiguous particles were alternately greater and less than the ultimately constant distance to which they converged as we passed further and further from the end. After the first nine or ten particles, the arrangement became uniform.—A communication by Dr. Thomas Muir, on the theory of Jacobians in the historical order of development up to 1841, was also received.

Paris.

Academy of Sciences, February 17.—M. Bouquet de la Grye in the chair.—A study of the conditions to be realised in the execution of negatives in order to obtain homogeneity and the maximum of exactitude in the determination of the coordinates of stellar images. Formulæ for evaluating the influence of the whole of the causes of error which affect the results, by M. Lœwy. The rectilinear coordinates of photographic stellar images are liable to two distinct classes of errors, the first being due to the unequal sensibility of the gelatine layer and to the irregular deformations which it undergoes during development, and the second having its origin in the subsequent measuring operations. A careful analysis of the relative magnitudes of these two causes of error in the case of stars of different orders of magnitude is given and a formula worked out for the probable error, from which it is hoped that a still higher accuracy may yet be obtained by the photographic method.—An apparatus for measuring differences of longitude with the aid of photography, by M. G. Lippmann. The essential part of the apparatus consists of a transparent mirror inclined at an angle to a mercury bath, and has already been described as a means of measuring photographically small zenithal distances. It is equally applicable to the measurement of small differences of longitude.—The action of potassium hydride on ethyl iodide and methyl chloride New methods of preparation of ethane and methane, by M. Henri Moissan. Potassium hydride heated in a sealed tube with ethyl iodide at about 200° forms ethane and potassium hydride. The reaction is not complete, but is perfectly free from bye-products. The ethane is separated from the hydrogen by means of liquid air, and from the ethyl iodide in excess by fractional distillation and subsequent washing with alcohol and water. The gas was proved by analysis to be perfectly pure. The reaction with methyl chloride is analogous, pure methane being produced.—Study of the vineyards of high yield in central France, by M. A. Müntz. It is shown to be more advantageous to moderate production in order to obtain a superior wine than to exaggerate the yield by methods giving enormous quantities of wine of feeble quality.—The estimation of sugars in the blood, by MM. R. Lépine and Boulud. A comparison of the polarimetric and copper reduction methods.—The mechanical action of gelatine on solid substances and particularly on glass, by M. L. Cailletet. Gelatine on drying exercises a very energetic mechanical action on the surfaces to which it adheres. On surfaces of glass, polished marble, Iceland spar and fluorspar, pieces are broken off, and a cylindrical tube of thin glass may be broken by means of the action of a small quantity of drying glue.—M. Charles André was elected a correspondant for the section of astronomy in the place of the late Dr. Gould.—Perturbations of the major axis of small planets, by M. Jean Mascart.—On quasi-entire functions, by M. Edmond Maillet.—On a class of partial differential equations integrable by successive approximations, by M. R. d'Adhémar.—On some transformations of contact, by M. W. de Tannenberg.—On a form of electric thermometer, by M. Georges Meslin. In certain cases the rapidity with which thermocouples follow the temperature changes of the medium in which they are placed is disadvantageous. The author therefore proposes to use the variation of electromotive force of a Latimer Clark cell with temperature as a thermometer, the thermal lag of which is very pronounced compared with a thermocouple.—Researches on ionised gases, by M. P. Langevin. A development of the theory of ionised gases of J. J. Thomson, together with an experimental confirmation of the theoretical deductions.—On the transparency of liquid conductors for the

Hertzian oscillations, by M. Charles Nordmann. The transparencies for the waves vary in the same sense as their resistances, increasing less rapidly than a direct proportion, but more rapidly than in proportion to their square roots.—The conductivity of liquid dielectrics under the influence of the radium and Röntgen rays, by M. P. Curie. Under the action of the radium rays there is a marked increase of electrical conductivity in liquid dielectrics, and on replacing the radium rays with the Röntgen rays, effects of a similar order are observed. The magnitude of the increase of conductivity observed under the action of the rays varies greatly with the liquid used, from 20×10^{-14} mhos per c.c. in the case of carbon bisulphide to $1 \cdot 3 \times 10^{-14}$ mhos per c.c. for liquid air.—Molecular fields of force, by M. S. Leduc.—A second quarter of meteorological observations at Quito, by M. F. Gonnessiat.—On praseodidymium chloride, by M. Camille Matignon. The anhydrous chloride can be obtained from the crystallised $PrCl_3,7H_2O$ by heating in a current of hydrogen chloride at 185° C. Thermochemical data are given for the heats of solution of the various hydrated chlorides.—On the diapedesis of leucocytes charged with lecithin, and on the absorption of the lecithin by the vascular endothelium, by MM. H. Stassano and F. Billon.—Comparison of the egg-laying capacity of fowls fed on meat and on grain, by M. Frédéric Houssay. It was found that on a meat diet there was a marked increase both in the number of eggs produced and also in the average weight of the egg obtained.—On the evolution of stolonial formations in Syllidians, by M. G. Pruvot.—On two caoutchouc-bearing plants of Indo-China, by M. Gustave Quintaret.—On the origin and the differentiation of the vascular meristem of the petiole, by M. Bouygues.—New observations on the *Tanghin du Ménabé* (*Menabea venenata*) and on its toxic and medicinal root, by M. Edouard Heckel.—On the properties of the reflection fringes of silvered plates, by M. Maurice Hsmy.

DIARY OF SOCIETIES.

THURSDAY, FEBRUARY 27.

ROYAL SOCIETY, at 4.30.—Note on the Discovery of a New Trypanosoma: Lieut.-Colonel David Bruce, R.A.M.C., F.R.S.—The Bakerian Lecture will be delivered by Lord Rayleigh, F.R.S., on the Law of the Pressure of Gases.
SOCIETY OF ARTS at 4.30.—The Industrial Development of India: Nilkanth B. Wagle.
INSTITUTION OF ELECTRICAL ENGINEERS, at 8.—Electric Shock and Legislation thereon: Major-General C. E. Webber, C.B., R.E.—Electric Shocks: F. B. Aspinall.—Electric Shocks at 500 volts (illustrated by a Demonstration of 500 volts): A. P. Trotter.

FRIDAY, FEBRUARY 28.

ROYAL INSTITUTION, at 9.—Gold Mining in Klondyke: Prof. H. A Miers, F.R.S.
PHYSICAL SOCIETY, at 5.—(1) On Focal Lines and Anchor-ring Wavefronts: (2) Contributions to the Theory of the Resolving Power of Objectives: Prof. J. D. Everett, F.R.S.—The Absorption, Dispersion, and Surface-colour of Selenium: Prof. R. W. Wood.
INSTITUTION OF CIVIL ENGINEERS, at 8.—Indicating High-Speed Steam-Engines: A. M. Arter.

SATURDAY, MARCH 1.

ROYAL INSTITUTION, at 3.—Some Electrical Developments: Lord Rayleigh, F.R.S.

MONDAY, MARCH 3.

SOCIETY OF ARTS, at 8.—Photography applied to Illustration and Printing J. D. Geddes.
VICTORIA INSTITUTE. at 4.30.—The Physical History of the New Zealand Fjords: J. Malcolm Maclaren.

TUESDAY, MARCH 4.

ROYAL INSTITUTION, at 3.—The Temperature of the Atmosphere: its Changes and their Causes: W. N. Shaw, F.R.S.
SOCIETY OF ARTS, at 8.—Structural Colour Decoration of the Interior of Public Buildings: G. C. Horsley.
ZOOLOGICAL SOCIETY, at 8.30.—Exhibition of Photographs of Animal-life in the Egyptian Soudan: E. N. Buxton.—On the Origin of Pearls: Dr. H. Lyster Jameson.—On the Organ of Jacobson in the Elephant-Shrew (Macroscelides): Dr. R. Broom.
INSTITUTION OF CIVIL ENGINEERS, at 8.—*Paper to be further discussed*: Electrical Traction on Railways: W. M. Mordey and B. M. Jenkin.

WEDNESDAY, MARCH 5.

SOCIETY OF ARTS, at 8.—Sound Signals: E. Price Edwards.
ENTOMOLOGICAL SOCIETY, at 8.—On Mr. Guy A. K. Marshall's Five Years' Experiments and Observations in Mimicry and Warning Colours in South African Insects: Prof. Edward B. Poulton, F.R.S., with an Appendix by W. L. Distant and Colonel C. T. Bingham.—Notes on some Cases of Sexual Dimorphism in Butterflies; with an Account of Experiments made by Mr. Guy A. K. Marshall: Dr. Frederick A. Dixey.—A Monograph of the Genus Acrida, with Notes of some Allied Genera, and Descriptions of New Species: Malcolm Burr.—(*a*) Notes on Hawaian Wasps, with Descriptions of New Species; (*b*) Four New Species and a New Genus of Parasitic Hymenoptera (Ichneumonidæ) from the Hawaian Islands; (*c*) On the Generic Characters of Hawaian Crabronidæ; Four New Genera Characterised: R. C. L. Perkins.
SOCIETY OF PUBLIC ANALYSTS, at 8.

THURSDAY, MARCH 6.

ROYAL SOCIETY, at 4.30.—*Probable Papers*: On the Spark Discharge from Metallic Poles in Water: Sir Norman Lockyer, F.R.S.—Experimental Researches on Drawn Steel. Part I. The Influence of Changes of Temperature on Magnetism. Part II. Resistivity, Elasticity and Density, and the Temperature Coefficients of Resistivity and Elasticity: J. R. Ashworth.—On the Effects of Magnetisation on the Electric Conductivity of Iron and Nickel: G. Barlow.—The Differential Equations of Fresnel's Polarisation-vector, with an Extension to the Case of Active Media: J. Walker.
LINNEAN SOCIETY, at 8.—On some New Species of Lepadidæ in the British Museum (Nat. Hist.): Prof. A. Gruvel.—On the Morphology of the Brain in the Mammalia, with Special Reference to the Lemurs, Recent and Extinct: Dr. G. Elliot Smith.
RÖNTGEN SOCIETY, at 8.30.—Localisation; with Demonstration of a Simple Direct Reading Apparatus: Dr. Barry Blacker.
CHEMICAL SOCIETY, at 8.—The Slow Oxidation of Methane at Low Temperatures: W. A. Bone and R. V. Wheeler.—Isomeric Additive Compounds of Dibenzyl Ketone and Deoxybenzoin with Benzal-*p*-toluidine, *m*-Nitrobenzalaniline and Benzal-*m*-nitraniline, Part III.; F. E. Francis.—Mesoxalic Semi-Aldehyde: H. J. H. Fenton and J. H. Ryffel.—*m*-Nitrobenzoylcamphor: M. O. Forster and F. M. G. Micklethwait.—Picrimidothiocarbonic Esters: J. C. Crocker.

FRIDAY, MARCH 7.

ROYAL INSTITUTION, at 9.—Radio-active Bodies: Prof. H. Becquerel.
GEOLOGISTS' ASSOCIATION, at 8.—The Zones of the White Chalk of the English Coast. III. Devonshire: Dr. A. W. Rowe.

SATURDAY, MARCH 8.

ROYAL INSTITUTION, at 3.—Some Electrical Developments: Lord Rayleigh, F.R.S.

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THURSDAY, MARCH 6, 1902.

THE VOYAGE OF THE "VALDIVIA."

Aus den Tiefen des Weltmeeres, Schilderungen von der deutschen Tiefsee-expedition. Von Carl Chun. (Jena: Gustav Fischer, 1900.) Lief. i.–xii. Price 18 mk.

ON the return of the German deep-sea expedition, it was decided to issue a popular account of the voyage and its results. Naturally this task fell to the leader, and in the volume before us Prof. Chun acquits himself of it.

The work opens with a short review of the history of deep-sea exploration, from the discovery by Sir John Ross in the year 1818 of living brittle-stars in 1000 fathoms of water to the outfitting of the German expedition in 1898—pages which will be read in this country with a justifiable pride indeed, but also with the conviction that exertion is needed if we are still to hold our own in scientific exploration. In enumerating the problems which yet remain to be solved, and for the discussion of which his expedition was to furnish material, Prof. Chun mentions the bionomics and embryology of deep-sea animals, the distribution equatorwards of polar organisms, and bipolarity, but he does not here refer to a question of considerable interest which has been greatly enlightened by the *Valdivia's* researches, the vertical distribution of the mesoplankton, which has been found, by the German expedition and by Dr. G. H. Fowler independently at almost the same time, practically to cease at about 1000 fathoms—a result which agrees neither with the view previously held in some quarters that pelagic life extended throughout the depth of the ocean, nor with the opposite opinion that it did not exist below two or three hundred fathoms.

The route of the cruise was determined by the decision to explore, as far as possible, portions of the ocean the deep-water fauna of which was as yet imperfectly known. Two of the most important of these being the South Atlantic and a great part of the Indian Ocean, the course decided upon was one which, passing through the Faroe Channel and thence southwards to the Canaries, followed roughly the western coast of Africa to the Cape, then struck south-west to Bouvet Island and south-east from Bouvet Island to the neighbourhood of Enderby Land, traversed the length of the Indian Ocean to the Nicobars, passing Kerguelen, New Amsterdam and Sumatra on the way, crossed from the Nicobars by Ceylon, the Maldives, the Chagos and the Seychelles to Dar-es-Salaam, and finally led back along the east coast of Africa, through the Red Sea and Suez Canal, to the Mediterranean and so home. Besides Prof. Chun, the expedition comprised ten scientific members, a photographer and a conservator. The vessel chosen was the *Valdivia*, a Hamburg to West Indies liner of 2176 tons register, and considerable alterations were made to fit her for the voyage, among others the fitting up of a large ice-room, which was found very useful in enabling deep-sea animals to be examined alive by being kept at a low temperature. The scientific equipment was very elaborate, and certain practical details are worth noting. Indiarubber accumulators, used to take the weight of the nets and their wire, were perished by the heat of the tropics, though fortunately others of steel spring were at hand. The "Blake" dredge proved less serviceable than a trawl, its iron frame cutting too deep into the ooze. The bucket of the vertical net was of glass and without filtering surfaces, whereby a smaller quantity of plankton was gotten, but in better condition. No doubt the quantitative net, built on Hensen's pattern, which was carried was provided with a porous bucket. Both Negretti and Zambra's upsetting thermometer and one of the Siemens electrical type proved useful, but the latter is said to need further improvements.

The history of the voyage is sketched in a series of chapters. These are written in a light and popular vein, and are beautifully illustrated by photographs of places and natives, but only a few points in them call for notice here. The important observations began when the Canaries had been passed. In the Guinea Stream, the low specific gravity of the water was found to be connected with a peculiarity of the plankton, the spines and other processes of which are longer than those of the forms found in the north and south equatorial streams. Dredging here gave poor results, but the deep-sea plankton is very rich. In lat. 25° 26′ S. was discovered, in 936 fathoms, a new bank, believed to form part of a ridge (the "Walfish ridge"), which parts the colder southern waters from the tropics, much as the Iceland ridge fends off the Arctic waters. The fauna of this bank is very rich. Careful dredgings were also made on the Agulhas bank, from which valuable results may be expected. There appears to be here an intermingling of Atlantic and Indian forms with typical Antarctic species, and Prof. Chun suggests that the latter are relics of a time when these waters were colder than at present.

One of the most important results of the expedition was the rediscovery of Bouvet Island in lat. 54° 26′ S. and long. 3° 24′ E. The *Valdivia* was only able to establish the existence of a single volcanic island some five miles by four, covered with an immense glacier, but the possibility is not excluded that a second may exist, corresponding to Norris's "Thompson Island." The search for this island in stormy weather amid mist and icebergs seems to have been a fine piece of work. Dredgings in the neighbourhood revealed a very rich fauna, intermediate between that of the Magellan region and that of Kerguelen, but with many new forms. Bouvet Island appears to be near the point of a tongue of cold water which extends northwards from the Antarctic region. On leaving it, the *Valdivia* coasted along the edge of the drift-ice which marks this tongue, in a south-easterly direction, till she was confronted with the edge of the pack-ice in the neighbourhood of Enderby Land. During the whole of this course, the water was of great depth, varying from 2000 to 3000 fathoms. The temperature curve was also very interesting. Owing to the presence of ice, the surface water is considerably cooler than that of intermediate depths, the actually coldest layer (about $-1^{\circ}{\cdot}5$ C.) being at 30–40 fathoms. Below this the temperature rises, till at 300–400 fathoms it is $1^{\circ}{\cdot}7$ C. Then it falls gradually and, at the bottom, is $-{\cdot}5^{\circ}$ C. Naturally, a number of icebergs were met with in this region, mostly of table form well known in the Antarctic and often of immense size. After a number of pages

devoted to an account of the origin and destruction of these bergs, Prof. Chun passes to a consideration of the Antarctic plankton. The *Valdivia's* researches were made at the height of the summer, when the surface fauna and flora were at their richest. In many respects they resemble those of the Arctic region, the most striking difference being the complete absence of Ceratium and the rarity of other dinoflagellates, the place of which was taken by immense numbers of diatoms, especially those of the genus Chætoceras. The greatest richness of the plankton was reached at 20–40 fathoms, the poverty of the surface waters being probably due to their lower specific gravity owing to the presence of melting ice. A twilight flora (Schattenflora), such as is found in the lower layers of the surface waters in tropical seas, is wanting in the Antarctic. On December 17, the ship was brought to a stand by the pack-ice some hundred miles north of Enderby Land in 2300 fathoms, and bore away north-west to Kerguelen. A dredging taken shortly after this showed a rather rich fauna and brought up a glacier-borne boulder of red sandstone, proving that Enderby Land is not of purely volcanic origin.

The voyage northwards across the Indian Ocean, which was saddened by the death of Dr. Bachmann, the physician and bacteriologist of the expedition, does not appear to have produced any very startling results. After leaving Padang in Sumatra, researches were made on the deep basin (some 1000 fathoms) between Sumatra and the Mentawi Islands. This basin is separated from the open ocean by a ridge of only 400 fathoms, on which the group is situated, and the bottom temperature is therefore higher (5°·9 C.) than that outside the islands. At the same time there is a very rich surface flora. Consequently the bottom fauna is extraordinarily rich. In this neighbourhood a specimen of Spirula was taken in perfect condition. A short visit to Suvadiva Atoll in the Maldives gives the author an opportunity for some remarks on that group. Since this visit, however, our formerly scanty knowledge of the Maldive Islands has been so vastly increased by Mr. Stanley Gardiner's expedition that the observations of the *Valdivia* are deprived of any value they might otherwise have had. Prof. Chun's ethnological conclusions are not very different from Mr. Gardiner's, but we very much doubt whether the latter author would accept the suggestion that the Maldives are built on a submarine mountain range. On the voyage to Diego Garcia, the very important discovery was made that the Chagos group and the Maldives are connected by a bank in 1100 to 1500 fathoms, this bank being sundered from that on which the Seychelles lie by a narrow channel only. The last section of the voyage in the Indian Ocean, that along the East African coast from Dar-es-Salaam northwards, in 500-700 fathoms, yielded the richest dredgings in the whole cruise.

At the end of the volume are some chapters on the deep-sea animals captured by the expedition and on general considerations concerning the oceanic fauna and flora. The "catch" was, on the whole, very much what might have been expected, and seems to contain many interesting forms, but few startling novelties. Hexactinellid sponges, actinozoa and echinoderms are naturally numerous, and giant forms of ostracoda, cirripedia and larvacea were taken. Deep-sea ctenophores were discovered, and some of the fish are perhaps even more bizarre than those that were already known from the deep sea. Naturally, the collections have not yet been sufficiently examined to enable general conclusions to be drawn from them with certainty, but Prof. Chun seems to incline to the view that the bottom faunas of the Arctic, Antarctic, Atlantic and Indian areas entitle them to be considered as distinct regions, in spite of the marked convergence between the members of the first pair and the identity of many species in the second. The surface fauna, and especially the surface flora, is much more peculiar in each region than the fauna of the bottom, but that of intermediate depths has a very uniform character in all, and, since many animals pass from the surface to lower layers of the water at fixed times of the year, it is possible to account for the cosmopolitan distribution of certain forms. On the subject of bipolarity, Prof. Chun is at present disinclined to pass an opinion.

To sum up in a few words the results of such an undertaking as the German deep-sea expedition is difficult. But it may, we think, be fairly said that not only have two or three discoveries of the first importance been made—such as the soundings in the neighbourhood of the Chagos group and off Walfish Bay, the "tailing off" of the pelagic fauna below 1000 fathoms, and the observations regarding Bouvet Island, but a mass of valuable information has been gathered which, when digested and discussed in the light of the facts accumulated by other expeditions, will set forward very notably our knowledge of the biology and physiography of the sea.

It is impossible to end a notice of this work without referring to the beautiful way in which it is brought out. The print, the margins, the numerous and artistic photographs, and the headpieces quaintly contrived out of representations of sea animals are all beyond praise and can only be made possible in a work issued at the price of the present one by a wide popular appreciation in Germany of the results of the expedition. What sort of public would such a work find in English?

L. A. B.

CHEMICAL ANALYSIS.

Practical Chemistry. By Abegg and Herz. Translated by H. T. Calvert, B.Sc. Pp. xiii+118. (London: Macmillan and Co., Ltd.) Price 6*s*.

THIS little work, which deals mainly with qualitative analysis, is based upon the principles of modern physical chemistry. The equations representing "reactions in solution" are written in the ionic form, thus :—

$$Mn^{\cdot\cdot} + 2OH' = Mn(OH)_2$$
$$Fe^{\cdot\cdot\cdot} + PO_4''' = FePO_4.$$

This method of representing reactions in solution as being entirely dependent upon the "ions" has its advantages, but it also has certain disadvantages. In most text-books the above equations would be represented by the action of definite salts, as, *e.g.*,

$$MnSO_4 + 2KOH = Mn(OH)_2 + K_2SO_4$$
$$FeCl_3 + Na_2HPO_4 = FePO_4 + HCl + 2NaCl.$$

When expressed in the latter form, students are apt to

suppose that the reaction only takes place when the special salt mentioned in the book is used, and if any other salt of the metal is offered to them to say, "but the book says such and such a salt is to be used." On the other hand, when the equations are expressed in the ionic form, as above, the student is perhaps inclined to forget that the anion of the metal and the cation of the reagent also interact.

There are those who look upon the "ionisation theory" as absolutely false and will have none of it. Others, mistaking theory for fact, ridicule all other theories and dogmatically state that *all* difficulties are surmounted when approached by means of the ionic theory. There are many, however, who, without subscribing to the opinions of the extremists, recognise in the ionic theory an extremely useful working hypothesis. Chemical analysis, which is apt to be dry and dull when viewed in —dare we say—the old-fashioned manner, becomes not only interesting, but many of the reactions which were obscure become clear in the light of the ionic theory. Thus, is the action of caustic alkalis upon ferric ferrocyanide (Prussian blue) always clear to students of the old regime? They are told that caustic alkalis decompose the compound according to the following equation :—

$$Fe_7(CN)_{18} + 12KOH = 4Fe(OH)_3 + 3K_4Fe(CN)_6 ;$$

but this does not explain why the whole of the iron is not precipitated as ferric hydrate. Now according to the ionic theory, this would be explained by saying that Prussian blue is dissociated into the cations $4Fe^{\cdots}$ and the complex anions $3Fe(CN)_6''''$ and that only the iron present as the cation is acted upon by the OH' of the potassium hydrate.

The arrangement of the book before us is in some respects peculiar. The student is first instructed how to construct a wash-bottle. This is followed on p. 3 by the preparation of hydrogen. The preparation of oxygen comes after that of hydrochloric acid and sulphuretted hydrogen, and is followed in succession by the methods of preparation of chlorine, sulphur dioxide, carbon dioxide and ammonia.

The analytical portion covers the usual ground and contains the usual reactions. Some portions of the chapter on "theoretical foundations" are far from clear, and we very much question whether the average reader will readily understand the two and a half pages on hydrolysis.

In a pocket at the end of the book there is a rather ingenious blank draught-board with the cations arranged along the top and the anions down the side. The compounds formed by the various ions are to be indicated in their proper squares, and if they are precipitates they may be indicated by shading or by filling in with coloured chalks.

The book has a table of contents, but no index. Even if the German edition was not indexed, surely the translator might have supplied one.

By the way, would it not be well if English writers of chemistry books would arrange always to write the positively charged ion in the same way? As it is, we find it sometimes spelt cation and sometimes kation.

F. M. P.

THE MOVEMENTS OF THE FOOT AND WRIST.

Der Gang des Menschen. iv. Thiel. *Ueber die Bewegung des Fusses und die auf denselben einwirkenden Kräfte.* Von Otto Fischer. Pp. 86 ; 3 plates. (Leipzig: Teubner, 1901.) Price Mk. 5·50.

Ueber die Bewegungen in den Handgelenken. Von Rudolf Fick. Pp. 54 ; with 8 figures in text and 10 plates. (Leipzig: Teubner, 1901.) Price Mk. 6·50.

IT is strange that two men, working side by side within the same university, publishing results of investigations on similar subjects in consecutive pages of the *Proceedings* of the same learned society, should produce two treatises so diverse in nature as those of Dr. Otto Fischer and Prof. Fick. Each employs a peculiar and comparatively new method for the solution of problems which have been thumbmarked by ten generations of anatomists. Dr. Fischer is a mathematician as well as an anatomist, a combination so rare that, in applying the later methods of mathematical physics to the elucidation of the movements of the human body in walking, he has left his colleagues far behind and is almost without audience or critic. Prof. Fick's paper is the result of the application of Röntgen rays to the study of the complex movements of the wrist-joint, a method only comparatively new.

If these authors differ in the methods they have employed they are alike in this, that they are minute, painstaking and accurate, investigating fully every fact for its own sake, with no thought whatsoever as to its utility. Prof. Fick has determined in millimetres the extent and direction of the movements undergone by each of the nine carpal bones during flexion, extension, abduction and adduction of the wrist. In the last paragraph of his paper he sums up his main result as follows :—

"In conclusion I would once more emphasise, what this research has again demonstrated, that the mid-carpal joint is indeed no paltry minor articulation (Kein unwichtiges Nebengelenk) deserving the stepmotherly consideration (stiefmütterliche Berucksichtung) extended to it by most practitioners, but that, for many movements of the hand, it is emphatically the chief joint."

In this conclusion the author, as he himself explicitly states, only verifies the observation made many years ago by Henke. The elaborate and expensive plates, the type and style in which Prof. Fick's work has been published, make an English anatomist envy the wealth of a German society that is able to devote so much of its funds to the elucidation of so small a part of the human body.

In his last contribution to the Kinematics of the human gait, Dr. Fischer dealt with the movements of the lower extremity during the cycle of a double stride; in this, his fourth contribution, he considers the movements of the foot during a corresponding period. The foot is dealt with as if it were detached from and independent of the rest of the body. The forces which act on it during the cycle of a double stride are traced to four sources, viz the muscles (extensor and flexors of the foot), weight of the body, weight of the foot and reaction of the ground. The points at which these forces are applied and the centre of gravity of the foot are determined and diagrammatically represented. The velocity and acceleration of the

centre of gravity of the foot, in the forward, lateral and vertical directions, during the period of a double stride, are determined and diagrammatically represented in three very carefully prepared plates. A. K.

OUR BOOK SHELF.

Ueber angewandte Mathematik und Physik in ihrer Bedeutung für den Unterricht an den höheren Schulen. Nebst Erlauterung der bezüglichen Göttinger Universitätseinrichtungen. Vorträge . . . gesammelt von F. Klein und E. Riecke. Pp. viii + 252. (Leipzig: Teubner, 1900.)

THIS miscellaneous collection falls into two parts. The first consists of eight lectures delivered to teachers in higher schools during a vacation course at Göttingen; of these the first is a sketch of the history of the Physical Institute at Göttingen and the instruction given there; the others deal with various technical branches of applied science in which mathematics plays an important part. The second and probably, to the English reader, the more interesting part of the volume is a reprint of various essays and addresses by Prof. F. Klein, in which he discusses the relation of universities to technical high schools (technische Hochschule). Prof. Klein is clearly of opinion that in Germany these two classes of institutions have become unduly isolated from each other, and should aim at greater solidarity, working loyally for their common welfare.

As one who is interested in the work of both, as well as in the good of the State, he deprecates the tendency in the universities, on the one hand, to divorce the study of mathematics from its practical applications, and in the technical schools, on the other, to take too narrow a view of mathematical science and regard it *merely* as subsidiary and subordinate to the requirements of practical engineering and the like. These tendencies are not wholly unknown in England, and Prof. Klein's arguments and suggestions deserve the attention of our mathematicians and teachers of applied science both in the universities and elsewhere. M.

The Ethical Philosophy of Sidgwick. By F. H. Hayward. Pp. xxiv + 275. (London: Swan Sonnenschein and Co., Ltd., 1901.) Price 4*s*. 6*d*.

A MOST useful though modest and unpretentious little work. In the nine essays of which it is composed the author summarises the main features of the doctrine of the "Methods of Ethics," and discusses from the point of view of an admiring but candid and discriminating reader the principal difficulties of Sidgwick's position. On the vexed question whether Sidgwick is in his ethics fundamentally an egoist or not, Mr. Hayward decides, after a careful examination, in the affirmative, with good reason as the writer of this notice thinks. A good feature of the book is the very full and impartial statement of the controversial arguments against Sidgwick urged by evolutionists on the one side, and neo-Kantians on the other. The care with which the changes in the successive editions of the "Methods" have been noted and allowed for and the thoughtful provision in the opening pages of a summary of Sidgwick's often prolix argument add to the value of a book which all students of ethics will find useful and suggestive. If the book should reach a second edition perhaps the author will tell us more definitely how far he regards the presence of apparently conflicting points of view in the "Methods" as due to excessive care in formulating a delicately balanced and consistent theory, and how far to the attempt to unite together elements which are really irreconcilable. At present he seems to hesitate in his verdict. As a scholar it is to be trusted he will purge future editions of such misspellings as "Königsb*u*rg" and ἐνεργεῖα, and such ugly formations as "perfectionistic" and "introspectionist." A. E. T.

On Traces of an Indefinite Article in Assyrian. By R. Campbell Thompson, M.A. Pp. 31. (London: David Nutt, 1902.) Price 2*s*. 6*d*.

IN this interesting pamphlet the author has attempted to throw some light upon an obscure point of Assyrian grammar, which for some years past has engaged the attention of Semitic scholars, although no completely satisfactory explanation has hitherto been given of it. The point to be explained, and to which attention was first called by Dr. Flemming, is the occasional occurrence of Assyrian and Babylonian words in which the case-endings have been dropped, although the words in question are not in the construct state. The explanation which is now generally accepted, and which was first put forward by Prof. Jensen, assumes that the dropping of the case-endings was a result of the degeneration of the language, a process which finds a parallel in modern Arabic. Mr. Thompson, however, suggests that we may see in the omission of the case-endings traces of an absolute state in Assyrian, similar to that in use in Aramaic; and, assuming this to be the case, it follows that the noun with the case-endings possesses the force of the emphatic state in Aramaic, although it appears to have no equivalent for the post-positive article. Mr. Thompson has arranged his examples to illustrate the rules which hold good for the absolute in Syriac; but he does not run his theory to death, and is fully conscious that the occurrence of variants with the case-endings shows that "the noun need not of necessity adhere to any fixed law."

We cannot here go into detailed criticism of the examples cited, but will only refer to one fact which appears to us to favour the received explanation rather than that here put forward. According to Mr. Thompson, the omission of the case-endings is due to *survival*, and not to degeneration. We should expect, therefore, to find the examples of its occurrence commoner in the early texts than in those of the later periods; as a matter of fact, the reverse appears to be the case. In the Old-Babylonian inscriptions, the case-endings (apart from the use of the construct) are rarely omitted, while the most striking examples of their omission occur in Assyrian and Neo-Babylonian texts. We must congratulate Mr. Thompson on the clearness and brevity with which he has stated his case, and Assyriologists will find the collection of extracts he gives most useful for a study of the question.

Sir Thomas Browne's Notes and Letters on the Natural History of Norfolk. Edited by T. Southwell. Pp. xxvi + 102. (London: Jarrold and Sons, 1902.)

NORFOLK sportsmen and naturalists—and they are many—will be sure to find much to interest them in a work dealing with the fauna of their county as it was in the middle of the seventeenth century, when, as the author tells us, cranes were often seen in hard winters, while bustards were comparatively abundant, although never, perhaps, so common as is often supposed. Sir Thomas Browne, it appears, was a Norwich physician who in early life travelled much. Although not to be compared in point of interest with those of Gilbert White, his letters and notes indicate a keen and shrewd observer of natural history. A large part of the value of the work is, however, due to the editor, who is well known for the keen interest he takes in all that concerns the natural history of the county. Not only has he deciphered with rare skill and patience a vast amount of crabbed MS., but he has contributed a series of foot-notes containing much valuable and interesting information. R. L.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

Botany by Indian Foresters.

A GLANCE at the *Indian Forester* for February affords a complete refutation of recent charges brought against the Indian Forest Department for neglect of botany.

This number commences with a most able and interesting account of the forests of the Sudan, written by Mr. Muriel, of the Indian Forest Department, who was sent last year to examine the forests along the Blue and White Niles and the Bahr-el-Ghazel. After travelling for 4600 miles, Mr. Muriel wrote a description of the chief components of the Sudanese woodlands and savannahs, and especially of the cultivation of *Acacia verek*, the Sudanese gum tree, from which last year 80,000 cwt. of gum, valued at 80,000*l*., was delivered at Khartum.

Ordinary timber is valued at 2*s*. a cubic foot at Khartum, while large quantities of wood fuel are required for steamers on the Nile and for locomotives, as well as for culinary purposes, so that the importance of the protection of the forests against incendiary fires and unrestricted grazing and felling is evident. Mr. Muriel has given a very interesting account of the fauna of these regions as well as of their flora, and it is satisfactory to learn that the very able forester and botanist, Mr. A. F. Broun, who has recently assisted Sir D. Brandis at Kew in his new book on the Indian forest flora, has been appointed Conservator of Forests in the Sudan.

In the same number of the *Indian Forester* is a paper by Mr. A. W. Lushington, of the Indian Forest Service, on the identification of seventy-four Indian species of Loranthaceæ by means of their ramification and leaves. He states that it is not uncommon in southern India to find forests completely ruined by these parasites. "The vegetation, weakened by forest fires, is incapable of battling with these pests, and as the better species of timber trees are less well supplied with sap than the inferior species, the former are the first to be killed." As the Loranthaceæ are classified by their flowers and the latter exist only for a short period, while the forest officer has a very large district to supervise and may not meet with some of the species in flower, the utility of Mr. Lushington's work is apparent.

Babu Upendranath Kanjilal, of the Indian Forest Department, has just published a most excellent and handy volume on the local forest flora of the School Circle, North-West Provinces of India, where the forests range in altitude from 1000 to 10,000 feet above sea-level. This work is also referred to in the February number of the *Indian Forester*, in which is also found a list, systematically arranged, of trees and shrubs in the Jerruck division of Sind, by Mr. G. K. Betham, of the Indian Forest Department.

Any habitual reader of the *Indian Forester* will see that Indian forest officers pay considerable attention to biology, chiefly as regards plants and insects; but, after all, their chief duty is the economic management of the Indian forests, and the great amount of work this involves and its value to the Indian Empire can be appreciated only by those who have given a fair attention to forestry in all its bearings.

Besides British India and the included and adjoining native States, such as Cashmere, Indian foresters are now employed in Siam, the Philippine Islands, Cape Colony and the Sudan. Owing to the great devastation of woodlands in the Transvaal and Orange River Colonies, which is graphically described in a recent number of the *Revue des Eaux et Forêts* (the *French Forestry Magazine*), it is to be hoped that a sound administration of forestry may soon be established in these territories.

Coopers Hill, February 24. W. R. FISHER.

Cherry Disease.

MY attention has just been called to a letter in your issue of January 30 from Sir W. T. Thiselton-Dyer, which gives the strongest possible confirmation to my contention that a fully equipped State Agricultural Laboratory is a national desideratum, and that in this respect Britain is behind other countries.

Your correspondent implies in his letter that with Kew and the British Museum in existence there is no pressing need for any other institution. The Director's letter proceeds to relate what Kew has done "promptly and in ordinary routine" for the protection of the British farmer against the cherry disease; and the sum of it is that in November, 1900, Kew answered an inquiry from Mr. A. O. Walker by telling him that the fungus on the cherry leaves sent by him was *Gnomonia erythrostoma*. The next step taken by Kew—and the only public one—is the director's ungenerous criticism of what has been done meanwhile by the Royal Agricultural Society. (Mr. Walker's letter to the *Gardeners' Chronicle* in May, 1900, was apparently his own private action, in no way initiated by Kew, and was certainly not an official step.)

A pathogenic fungus can be named at any time in ordinary routine for an individual inquirer either at Kew or at the British Museum; but this is the smallest part of the work of a State Agricultural Laboratory.

The Royal Agricultural Society of England, which—public-spirited though it be—is not a State-supported institution, took some practical steps. It was not until December 1900 that a specimen of the cherry disease was received at the laboratory of that Society, and at the next council meeting on February 5, 1901, I reported on the disease. This report was published in the agricultural papers of that and the following weeks, and was widely distributed in leaflet form by the Society among the Kent cherry-growers, to its own members and to non-members indiscriminately. A conference with the cherry-growers at Maidstone followed, and the result has been that the disease was carefully observed, and sufficient information reached the Society's laboratory to enable the publication in its *Journal* of a detailed account of the disease as it has appeared in England. I regret to add that I have received specimens of wild cherry from Somerset attacked by the Gnomonia.

Any benefit which may conceivably have come to the British farmer from Kew in this matter accrued indirectly in May through the action of a private individual. The Royal Agricultural Society had already in February taken the valuable practical steps which in most other countries would have been the duty of a State Agricultural Laboratory.

I need not trouble you in regard to your correspondent's kind correction of an intentionally indefinite description in my report, which has been put right in its final form, issued ten days before his letter was published; nor with his other criticisms upon your report of the meeting of the Royal Microscopical Society, criticisms which to an intelligent and careful reader answer themselves. WILLIAM CARRUTHERS.

44 Central Hill, Norwood, February 22.

MR. CARRUTHERS' letter is open to some criticism. Taking it, however, as it stands, it proves conclusively that in the case of the cherry-leaf disease everything has been done by existing agencies that was practically possible. This particular instance therefore affords no basis for the demand for a State Agricultural Laboratory.

As I have already stated, the disease does not appear to have been brought under the notice of the Board of Agriculture. Had it been so, that department, if it had seemed desirable, could have relieved the Royal Agricultural Society of the task of preparing and distributing a leaflet. Mr. Walker, however, points out in NATURE for February 6 (p. 318) that "the disease has almost disappeared, though no preventive measures such as stripping the leaves were taken."

The object of my letter was to make a protest against the present tendency to demand fresh State machinery instead of endeavouring to increase the usefulness of that which already exists. W. T. THISELTON-DYER.

Kew, February 26.

Identity of Negative Ions Produced in Various Ways.

FROM the results of some experiments which I have recently made, it can be shown that the negative ions produced in various gases by Röntgen rays, or by collision, are all identically the same and are smaller than the molecules of hydrogen.

The following results have been established by the researches on this subject which have been already published (J. S. Townsend, *Phil. Mag.*, February 1901; J. S. Townsend and P. J. Kirkby, *Phil. Mag.*, June 1901; P. J. Kirkby, *Phil. Mag.*, February 1902):—

(*a*) The negative ions produced in a gas by Röntgen rays

generate other ions by collisions with the molecules of the gas when they move sufficiently rapidly.

(*b*) For any gas the negative ions which are generated by collisions are the same (having the same properties over wide ranges of force and pressure) as those which were generated by the rays.

(*c*) If α is the number of negative ions generated in a gas by one of these negative ions moving through one centimetre, then $\alpha = pf\left(\frac{X}{p}\right)$, where p is the pressure of the gas and X the electric force acting on the ion.

(*d*) The free paths of the negative ions are long, compared with the free paths of the molecules, so that their linear dimensions must be smaller than those of the molecules.

From a comparison of the properties of positive and negative ions, it can be seen that the mass of the negative ion must be small compared with that of the positive ion.

The values of α were determined for large ranges of pressure and electric force for air, carbonic acid and hydrogen, and the functions f have been represented graphically by three curves. Let f_1, f_2 and f_3 denote the functions f found for air, carbonic acid and hydrogen respectively as determined by the experiments with Röntgen rays.

The results which I have to add to these were obtained by finding the conductivities of gases between parallel plates when one of the plates is illuminated by ultra-violet light.

The experiments have led to the following conclusions:—

(*a'*) The negative ions set free from a zinc plate when ultra-violet light falls on it generate other ions by collisions with molecules of air, carbonic acid or hydrogen.

(*b'*) The negative ions thus generated by collision in the gases have the same properties (over large ranges of pressure and electric force) as the ions generated by the light from the zinc.

[Hence these four kinds of ions are identical, viz., the ions given off from the zinc plate and the negative ions which they produce in air, carbonic acid or hydrogen. These negative ions may be denoted by the letter Z.]

(*c'*) If α' is the number of ions which one of the Z ions produces per centimetre by collisions with molecules, then α' is connected with the electric force and the pressure by an equation of the form $\alpha' = pf'\left(\frac{X}{p}\right)$. The three functions f_1', f_2', f_3' as determined in this manner for air, carbonic acid and hydrogen are equal respectively to the corresponding functions f_1, f_2, f_3 as determined by the experiments with Röntgen rays. The equality extends over the whole ranges of pressures and force which have been examined.

Consequently the negative ions generated by Röntgen rays in a gas are precisely the same as the ions set free from a zinc plate by ultra-violet light.

If it be questioned that the identities $f_1 \equiv f_1'$; $f_2 \equiv f_2'$; $f_3 \equiv f_3'$ are sufficient to justify this conclusion we may proceed to establish the proposition in the following manner:—

The charges on negative ions produced by Röntgen rays in any of the gases under consideration have been shown to be equal to the charge on a negative ion given off from a zinc plate by ultra-violet light (J. S. Townsend, *Phil. Trans.* 1899 and 1900).

For simplicity, one of the gases may be considered, air, for example. Let m be the mass and e the charge on a negative ion R produced in air by Röntgen rays, and let m' and e' be similar quantities for an ion Z produced by the aid of ultra-violet light.

Since the maximum values of f_1 and f_1' as determined by the larger values of $\frac{X}{p}$ are equal the two kinds of ions R and Z must produce the same number of collisions per centimetre so that they have the same free paths. For any force X, the kinetic energy that the R and Z ions acquire along their free paths must be equal since their charges are equal. At the end of a path of length x the value of $\frac{mv^2}{2}$ or $\frac{mv'^2}{2}$ is equal to Xex.

Hence we have the equation $mv^2 = m'v'^2$, v and v' being the velocities of the ions R and Z before collision.

A second independent equation is obtained when we consider the identity $f_1 \equiv f_1'$.

The chance of producing new ions by collision is not determined by the energy of the colliding ion. If this were the case, the positive ions would produce others by collision under an electric force X if their mean paths became equal to the mean paths of the negative ions when they generate others under the action of the force X. It is easy to show that the positive ions do not acquire the property of producing others by collision even when their free paths are much longer than those of the negative ions when they are giving others by collisions. The negative ions therefore possess this ionising property in virtue of the large velocities they acquire along their free paths. It is therefore evident that the function f involves the mass and velocity of the colliding ion in some form which is not reducible to the product $m \times v^2$. The equality of f_1 and f_1' for the same values of e, X and p supplies us with an equation between m, v, m', v', of the form $\phi(m, v) = \phi(m', v')$. Combining this equation with the equation $mv^2 = m'v'^2$, we see that $m = m'$ and $v = v'$.

Hence the masses of the two ions R and Z are the same as well as their free paths and charges. We thus see that it is possible, by various methods, to detach negatively charged particles from the molecules of gases which are small compared with the molecules, and that the particles which are detached are the same from whatever gas they are removed.

JOHN S. TOWNSEND.

New College, Oxford, February 28.

The Recent Fall of Red Dust.

SOME observations made last autumn in Cornwall may throw light on the fall of dust in South Wales. On September 2, during gusty weather with squalls from the E.N.E., I watched from my window at Carbis Bay (270 feet above the sea) puffs and swirls of dust rising from the desert-like flat at the mouth of the Red River. The dust-cloud rose above the top of Godrevy Towans (230 feet), nearly blotted out Godrevy Lighthouse and then spread in a well-defined belt across St. Ives Bay for more than three miles to near St. Ives Head, which it must have passed, though this part of the track was invisible from my point of view. A fortnight earlier a similar observation had been made under identical conditions by Mrs. Reid. On neither occasion did the wind reach the force of a gale, it was merely a strong, dry east wind.

The red mud which gives its name to the Red River is mainly slime produced by the crushing of the tin-ore in the stream-tin works. This mud spreads far and wide over the alluvial flats and along the sandy shore; when it dries it forms an almost impalpable dust. Much of this dust is mixed with the Cornish sand-dunes, and drifts to and fro with the shelly sand, which forms the main part of those dunes. If the dust-falls in South Wales are of Cornish origin, the material will probably contain a good deal of finely powdered schorl, which mineral occurs abundantly in the tin-ore.

CLEMENT REID.

The Validity of the Ionisation Theory.

THE number of NATURE which appeared on January 30 contains an abstract of a paper by L. Kahlenberg entitled "The Theory of Electrolytic Dissociation as viewed in the Light of Facts recently Ascertained." In the paper referred to is a kind of summary of observations which have been made on non-aqueous solutions, from the consideration of which the author draws the conclusion that the electrolytic dissociation theory is untenable in the case of non-aqueous solutions.

In view, however, of the generally accepted opinion that this theory is in good accordance with experimental observations on aqueous solutions, Kahlenberg has been led to investigate such solutions more closely. As the result of a large number of boiling-point, freezing-point and conductivity determinations, the conclusion is drawn that "the difficulties which the theory of electrolytic dissociation encounters in explaining the phenomena in aqueous solutions are really insurmountable."

One of the chief reasons for this inference appears to be that the series of molecular weight values calculated from the cryoscopic and ebullioscopic measurements at different concentrations of the solutions are irregular. As an example, it is found that in the case of solutions of magnesium sulphate, the calculated molecular weight, which even in the most dilute solution is greater than the theoretical value, increases at first with the concentration, passes through a maximum and then decreases, attaining a value which would correspond to electrolytic dissociation only in the most concentrated solutions. The author does not state in what manner these "molecular

weights" have been calculated, but presumably the ordinary formula has been employed. It is important to note that in seven out of the nine boiling-point measurements carried out with magnesium sulphate, the concentration of the solution varies from about 15 per cent. to over 40 per cent. In other experiments with solutions of cane sugar, concentrations varying from 20 grams to 290 grams of sugar per 100 grams of water have been employed, the calculated "molecular weight" (theory = 342) decreasing from 360 to 212 at the highest concentration.

To attribute to the numbers calculated by means of the simple boiling-point formula for solutions of such concentrations the significance of molecular weight values can scarcely be regarded as justifiable. In so far as the ordinary freezing-point and boiling-point formulæ rest on a thermodynamical basis, they only hold good for ideal solutions; for such solutions the formulæ in question will give molecular weight values, but it has yet to be shown that the numbers calculated by Kahlenberg from his experiments can be taken as representing molecular weights.

For moderately concentrated solutions which no longer satisfy the requisites of an ideal solution, distinguished by the properties that no heat is evolved or absorbed and no change of volume takes place when it is diluted, Ewan, amongst others, has deduced an expression connecting the osmotic pressure with the lowering of the freezing point, the formula resting on a thermodynamical basis. This formula, when used for the calculation of molecular weights, gives, even with solutions containing as much as 40 per cent. of cane sugar, values scarcely differing from theory (342), whereas the simple freezing-point formula for a solution of the concentration mentioned gives 275.

Another reason advanced by Kahlenberg to prove the inadmissibility of the ionic theory is the lack of agreement between the numbers representing the degree of dissociation as calculated from the conductivity on the one hand and the freezing- or boiling point on the other. If for the reasons previously stated the calculations based on the boiling-point and freezing-point measurements have little significance so far as the ionic theory is concerned, it is obviously impossible to effect the required comparison. Furthermore, it seems questionable whether the numbers calculated by the formula $\alpha = \frac{\mu_v}{\mu_\infty}$ really represent degrees of dissociation. The formula involves the as yet unproved and scarcely probable assumption that the ionic velocities are the same in solutions of all possible concentrations. The development of the ionic theory is by no means conditioned by the validity of such a formula. So far as Kahlenberg's measurements are concerned, the comparison between the results of the boiling-point and conductivity measurements is moreover, impossible, except in the case of the binary salts, since the range of concentrations employed is quite different.

Although, therefore, the publication contains a large number of valuable empirical data, yet it cannot be allowed for one moment that the ionic theory has been shown to be untenable. It is far from the wish of the writer to minimise the difficulties which do admittedly confront the theory of electrolytic dissociation. It must not, however, be supposed that the theory has received its final and complete form; the possibilities of its rational expansion and development to explain existing irregularities are far from being exhausted. A warning note may be sounded against a too ready assumption that new experimental data prove the untenability of the theory without very careful consideration of what exactly is, and is not, stipulated by the theory. H. M. DAWSON.

The Yorkshire College, Leeds.

Birds attacking Butterflies and Moths.

I WAS much interested in the letter in NATURE of January 16 on the frequent capture of butterflies in India by the King Crow, as some years ago I experimented with a captive bird of this species, and found that it avoided "warningly-coloured" butterflies when possible, and was deceived by mimicry (*J. A. S. B.*, ii. 1897, p. 651).

With regard to the capture of butterflies by bush-haunting birds which do not take them on the wing, I pointed out as long ago as 1895 (*J. A. S. B.*, ii. 344) that the common Babbler *Crateropus canorus* was likely to meet with butterflies in repose, and proved experimentally that it dislikes the "warningly-coloured" species. But I could then give no positive evidence that it does, as a matter of fact, attack butterflies on its own account, though it will take them if thrown in its way.

I therefore give here the results of a few experiments which, in my opinion, show that this bird also naturally preys on butterflies.

In March last year I gave to a wild-caught bird of this species a *Danais limniace* together with a Junonia. The bird took and ate the latter; I then removed the Danais.

I have just now been offering three specimens of *Danais genutia*, together with three plain brown butterflies, to three wild-caught adult Babblers placed in separate cages.

Two of the birds disregarded the Danaids until they had eaten the other butterflies, and then did not attack them eagerly or eat them (except the abdomen in one case), although they had no food in their cages at the time.

I conclude, therefore, that they were last year's birds, which knew and disliked *D. limniace*, and the present two *D. genutia*, from previous experience in catching and tasting butterflies when wild.

The third bird experimented with to-day attacked its specimen of *D. genutia* first, but soon left it to eat the other butterfly given; nor did it tear the Danais to pieces as did the others, although, like them, it had no other food in its cage.

Either, then, this bird had forgotten its wild experience, or, what is more likely, it had never happened to catch *D. genutia*, and so knew nothing about this species, which it evidently disliked, from what has been said above, although it was not impressed by the "warning colours."

In my previous experiments with this Babbler I did not observe the same precautions, when *first* offering the butterflies to the birds, as I did in these later experiments, so that the results I obtained, although sufficiently demonstrative of the preferences of the species, threw no light on the individual experience of the specimens experimented with. F. FINN.

Indian Museum, Calcutta, February 6.

SI cela peut intéresser vos lecteurs : . . . dans une traversée de la Mer des Caraïbes sur le steam. angl. *Mariner*, en Mai, 1886, nous fûmes, par un temps calme, assaillis par un grand nombre de tout petits oiseaux, bien qu'à une assez grande distance de la terre, invisible. Ils poursuivaient de petits papillons qu'ils venaient happer au vol jusques sur mes genoux. J'étais assis très fatigué et un peu inerte sur la dunette. Je ne pouvais songer à déterminer oiseaux ni insectes. Les matelots laissaient faire. La brise fraîchit et tout ce petit monde disparut en un clin d'œil. Que sont-ils devenus ? AD. NICOLAS.

Angers (M.-et-L.), le 22 Février.

On Prof. Arrhenius' Theory of Cometary Tails and Auroræ.

IN the more or less popular accounts which have recently been given of Prof. Arrhenius' theory of cometary tails and the auroræ, it is generally stated that the smaller the diameter of the corpuscle upon which the light is falling the greater the excess of light-pressure over gravitational force. This explanation, however, holds only so long as the diameter is greater than the wave-length of light. If the diameter becomes of the same order as the wave-length, the ratio between light-pressure and gravitation follows an entirely different law. This has recently been demonstrated by Prof. Schwarzschild by an exhaustive mathematical treatment of the question in a paper entitled "Der Druck des Lichtes auf kleine Kugeln und die Arrhenius'sche Theorie der Cometenschweife" (*Sitzungsberichte* der k. b. Academie der Wissenschaften zu München, 1901, Heft iii.). The conclusions arrived at in this paper are of considerable importance in so far as they show that the effect of gravitation is exceeded by that of the pressure of light only so long as the diameter of the corpuscle is greater than about $0 \cdot 07 \mu$. For this limiting value the two forces are exactly balanced; but for smaller values of the diameter the light-pressure becomes rapidly less, so that it is then always exceeded by gravitation. It would appear from Prof. Schwarzschild's computations that the globular corpuscles thrown off in the tails of comets should have diameters not smaller than $0 \cdot 07 \mu$ and not exceeding $1 \cdot 5 \mu$, supposing the specific gravity of the corpuscle to be that of water. Now these values far exceed the limits assigned to the dimensions of the molecules. According to our present knowledge, based on

theory as well as on experiment, we are forced to conclude that the diameter of a molecule cannot be larger than $0{\cdot}003\mu$. On the other hand, the specific gravity of a molecule of air, for instance, appears to be very great, viz. five times that of water (see Meyer, "Die kinetische Theorie der Gase"). This maximum value of the diameter of a molecule is so enormously smaller than the values demanded by Prof. Arrhenius' theory that the latter appears to be incompatible with any assumption which regards the cometary matter as being of a gaseous constituency. In order to explain the repulsion of matter in the tails of comets by the pressure of the sunlight, this matter must be assumed to consist of small drops, each of a bulk sufficiently large to harbour at least one million molecules within its bounding surface. Whether such an assumption can be justified appears to me very doubtful. At any rate, Prof. Schwarzschild's profound mathematical investigation makes it absolutely clear that the idea of minute electrically-charged corpuscles—of about one-thousandth the size of a hydrogen atom (see *Observatory*, February 1902, p. 103)—being propelled by the sun's light towards the earth and causing the various phenomena of auroræ, Gegenschein, &c., receives no support from the mathematical point of view. But, even apart from these difficulties, it can hardly be said that the ingenious theory of Arrhenius settles the question as to the nature of the force acting on the cometary matter. So far it offers no explanation of the remarkable phenomenon of the contraction of the coma with the approach towards the sun. Doubtless this *contractile* force is also of solar origin. But can it be identified with the force which repels the cometary matter in the direction of the radius vector? It appears to me that the theory in its present form only removes one difficulty by introducing several others. J. HALM.

Royal Observatory, Edinburgh, February, 20.

Experimental Geometry in Secondary Schools.

IN the report, in your issue of February 27 (p. 404), of a meeting of the Mathematical Association, it is stated to have been the opinion of most speakers that the study of demonstrative geometry should be preceded by a course of work with ruler, compasses and protractor, in which simple measurements and constructions form the chief part. The note continues with the statement that such a course has been adopted in Scottish schools, and in English elementary schools and kindergartens.

May I venture to point out that there are a considerable number of secondary schools where this kind of work forms a regular part of the curriculum in the lower mathematical classes (this has, for instance, been the case here for the past three years), and that it has been recognised as a valuable medium by which a boy's interest may be aroused in geometry before he is introduced to the very irksome and difficult task of assimilating Euclid's phraseology? C. A. RUMSEY.

Dulwich College, March 5.

The Zodiacal Light.

THE zodiacal light was visible here last night at 7h. 30m. p.m. The base at the horizon was about 16° wide; the axis of the cone pointed towards the Pleiades, but the apex did not reach much beyond α Arietis. At 7h. 45m. it was brightest; at 8h. it had faded out, possibly on account of mist in the air, as a fog set in about an hour afterwards. J. P. MACLEAR.

Chiddingfold, Surrey, March 4.

Contributions to Anatomical Journals.

PROF. HUNTINGTON, of Columbia University, has called my attention to a paragraph in an article on "A New Journal of Anatomy" in your issue of January 9 to which he, naturally, takes exception.

In justice to Prof. Huntington, I beg leave to state that he had no part whatever in the recommendation, acceptance or production of either of the papers on which your critic animadverts.

The first of these was accepted by one of my British co-editors and sent to me for publication, the author supplying the plates. For the second I, solely, am responsible.

The method of the higher criticism is not always trustworthy when its results can be checked by contemporary history.

ALEX. MACALISTER.

New Museums, Cambridge, February 14.

I REGRET to say that my statement concerning Prof. Huntington and the origin of the paper which I described was based on hearsay, and in face of Prof. Macalister's letter I can but tender Prof. Huntington my sincere apologies.

I am relieved to find that the author provided the plates.

February 26. THE WRITER OF THE REVIEW.

FURTHER DEVELOPMENTS IN WIRELESS TELEGRAPHY.

SINCE the article which appeared in NATURE last week was written, some further details concerning Mr. Marconi's Transatlantic signalling have been published, and also another success attained by the inventor has been announced. The information with reference to the latter point is contained in a telegram from the New York correspondent of the *Daily Telegraph*, which appeared in that paper on Monday last. Messages, it seems, were transmitted from Poldhu to the *Philadelphia*, whilst that ship, on board of which was Mr. Marconi, was on her way from this country to New York. Five messages in all were received, the first when the *Philadelphia* was at a distance of 250 miles from the Lizard, and the last on February 25, when the distance had been increased to 1551 miles. In addition, a signal of the much-talked-of letter "S" was received at a distance of 2099 miles. The news is confirmed by the following telegram from Mr. Marconi, which is contained in a letter from the Wireless Telegraph Co. to Wednesday's *Times*:—

"Health good. Received messages 1551 miles. Test letter at 2099. All on tape receiver. Records duly attested by ship's officers.—MARCONI."

The chief interest of these results lies in the fact that the received messages, including the signal "S," were recorded on the tape of the receiving apparatus, and not merely heard in the telephone, as was the case with the Transatlantic signal. Mr. Marconi must feel greatly gratified at thus having visible record of the success of his experiments in this instance, as it removes the possibility of the suggestion that he was deceived by the wish to hear being father to the thought that he heard. Messages were naturally only transmitted in the one direction, as the transmitting apparatus on board the *Philadelphia* was not so powerful as that at the Cornwall station.

The further details as to the Transatlantic signalling to which we referred above are published in an article on Mr. Marconi in this month's *Century Magazine*. This article, the proofs of which have been read by Mr. Marconi, contains an account of the development of wireless telegraphy, and is illustrated by a number of interesting pictures. We reproduce here a photograph of the transmitting station at Poldhu from which all the long-distance signals have been transmitted, which shows very clearly the group of twenty masts, each of which is 210 feet high. The power is obtained from an alternate-current generator of 38 horse-power. There is thus more than two hundred times as much power used as in the signalling apparatus installed on board ships using the Marconi system. It will be noticed that in the later work development has taken place rather along the lines of increasing the output of power than of using higher masts. Mr. Marconi, it is said, considers that a mast about 200 feet high is the most suitable from all points of view, and in some remarks, which we quote at the end of this article, states that he thinks that any desired distance could be bridged given sufficient power.

A good deal of objection is still raised on the question of syntony, and it is pointed out that although tuning has been obtained with sufficient accuracy to prevent interference, this does not prevent the picking up of messages by an outsider who should experiment with a

special view to finding the correct tune, or of the interference with signalling in a similar way. This fear is, however, somewhat imaginary, as it is doubtful whether such an enterprise would be commercially successful, and it is inconceivable that anyone should devote his energies to its realisation purely out of malicious rivalry. Even in war time, we think, it would hardly repay the labour, and, moreover, Marconi's system now promises to be of more use in peace than in war. It may be remarked, too, that syntony—especially syntony so thorough as that described by Prof. Fleming eighteen months ago, when two distinct messages were sent and received by the same transmitting and receiving wires—opens up the possibility of multiplex wireless telegraphy, which would be equivalent to a great increase in the speed of signalling.

We may finally quote some remarks made by Mr. Marconi on his arrival in America after his success with the experiments on the *Philadelphia.*

"I believe," he said, "that the distance at which a wireless message may be sent depends only on the power of the sending station. I think it possible to send a message entirely around the world, to start the message eastward around the globe, and to receive it at the same station from the westward.

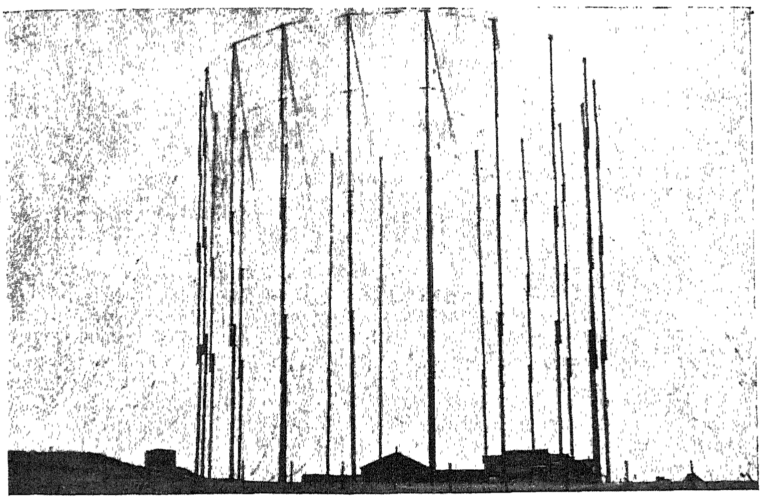

FIG. 1.—View of Poldhu Station, Cornwall, whence the signals came to Marconi at St. John's.

"I now know that the curvature of the earth does not in the least affect the waves. Many people who have reasons for hoping so have said that this would prove a fatal defect to the system, but it is not so. During the voyage I carried out a number of experiments which I had long wanted to make, but which I had never attempted before. You must pardon me for not disclosing their nature. All I can say is that they were eminently satisfactory to me." M. S.

THE METROPOLITAN HOSPITALS AND VIVISECTION.

WE have recently received the new edition of a pamphlet entitled "The Metropolitan Hospitals and Vivisection, a Guide for the Charitable in the Disposition of their Gifts and Bequests," by the Hon. Stephen Coleridge. The pamphlet begins with a prologue which consists of a short phrase snatched without any context from a speech delivered by the Home Secretary. Owing to the shorn character of this phrase, which stands out grotesquely framed with interpolations, we are unable to say what the Home Secretary really meant. The author, however, draws an inference which certainly is not justifiable, viz. that serious operations without anæsthetics necessarily involve the torture of animals. Whether this is so or not depends entirely upon what is meant by a serious operation and what is meant by torture, concerning neither of which is a word said. By torture we certainly do not mean mere momentary pain.

The main object of the essay is, however, threefold. In the first instance Mr. Coleridge, presumably satisfied, from his prologue, that the legalised torture of animals by so-called vivisectors actually takes place, and that no matter what its object may be is unjustifiable, classifies all metropolitan hospitals according to their supposed connection with vivisection. He further appeals to all those who have money to give, to enrich only those hospitals printed in plain type in his list, being the ones which at the present time are entirely free from vivisection and vivisectors. The second object of the monograph seems to be to denounce as diversion of charitable funds from their legitimate object any payment from the hospitals to the medical schools attached to them. There is also in addition to this an assumption that such payments are practically for the subsidy of vivisection so-called, and a further appeal to the charitable on this count. The third object is apparently to impugn the integrity of the committee for the distribution of King Edward's Hospital Fund.

First, then, according to Mr. Coleridge, the charitable should give only to those hospitals which at the time of their bequest are entirely free from all vivisection connections. It must be at once pointed out that this is a somewhat complicated affair, and will require very careful study upon the part of the donors, in that the staffs of hospitals change, and, further, a man of science once a vivisector is not always a vivisector. Since he does not vivisect for amusement, he does so only when he has a definite problem in his mind, and accordingly arranges a series of experiments capable of giving him a definite solution. From this it follows, as indeed the list in this pamphlet shows, that a hospital intimately connected with vivisectors one year may be entirely emancipated from them the next, and therefore that the terms of an anti-vivisection bequest will require alteration from year to year.

The hospitals at present free from all vivisection taint, according to the pamphlet before us, contain 4516 beds; of these 4500 beds, ethically, according to Mr. Coleridge, eligible for the gifts of the charitable, 1109, or practically one quarter, are devoted to lunatics or idiots. Now this fact surely should have been clearly stated, and also its corollary, viz., that should the charitable decide to support only those hospitals satisfying Mr. Coleridge's requirements for eligibility, one quarter of their subscription will be devoted to the maintenance of lunatics or imbeciles, extensive provision for which is already supplied out of the rates. Further, another fact of which the charitable, in Mr. Coleridge's sense, should be cognisant is, that of the remaining 3000 or so beds no less than 500, or approximately one-eighth of the original total, are devoted to the maintenance of incurables. Two-eighths of the subscriptions of the charitable should, according to Mr. Coleridge, go to lunatics, one-eighth to incurables. Of the remaining 2900 beds, 300 either belong to local cottage hospitals or are devoted to small-pox or other infectious diseases. The former hospitals

will receive a large measure of support, at least in many cases, from those locally interested in them, and accommodation for infectious diseases other than small local isolation hospitals is dealt with out of the rates. From this it follows that of any subscription given according to Mr. Coleridge's lines, little more than one-half will be devoted to what the average charitable man regards as the essential function of a hospital, viz. the treatment of acute medical and surgical disease and the rendering of the unfortunate subject of it capable of returning to earn his, and very often his family's, daily bread. We think it would have been fairer and of more real help to the charitable layman whom this pamphlet pretends to guide had these considerations been clearly set forth. Let him, then, now clearly understand that had he followed Mr. Coleridge's advice during, for instance, the year 1900, to which the figures in their entirety apply, and specifically stated that his money should go to no hospital connected with vivisection, practically half of it would have been "diverted" from the legitimate object of his charity.

To pass to a question which certainly does not possess the merit of novelty, viz. the so-called diversion of hospital funds to the medical schools attached to them, we would simply repeat what we have said before, that this is no diversion at all, no more diversion than the salary paid to a hospital gate-porter. The "managers" of the large hospitals are shrewd business men, we think more shrewd even than Mr. Coleridge, and they know full well that the efficacy of a large general hospital depends *inter alia* upon there being a medical school attached to it? The clinical teachers, demonstrators and students tend the sick and teach the nurses, thus securing efficient ones; the more purely scientific departments of the school help, each using the methods in which they are individually expert, in the elucidation of those obscure cases often demanding the technique of all. By these means the physician or surgeon becomes possessed of a knowledge of facts enabling him to adopt lines of treatment which mitigate pain, minimise the havoc of disease, and not seldom actually save life. Under the present regime these services are rendered by the medical schools gratuitously: sums granted towards the maintenance of these schools cannot be said to be diverted from the use of the sick; the sick get the full benefit of them.

If we now turn to Mr. Coleridge's impugnment of King Edward's Hospital Fund Committee, we shall arrive at some interesting deductions from the figures provided for our enlightenment which were not pointed out by the author. Mr. Coleridge has noted the fact that the allocation of the hospital fund grants per bed was greatest in the case of the hospitals possessing medical schools, and thus laboratories. In the case of the other hospitals, those which had upon their staff vivisectors received larger grants than those entirely unconnected with vivisection. *Post hoc propter hoc*, in other words, Lord Lister especially, and his colleagues to a less degree, have wilfully used King Edward's Hospital Fund for the purpose of endowing vivisection.

It is certainly to be assumed that King Edward's Hospital Fund was not intended for the endowment either of lunatic asylums or homes for the incurable, or local cottage hospitals, or local isolation or small-pox hospitals, which certainly ought to be provided for out of the rates. To no hospitals of this kind did the Committee, and we venture to think quite rightly, make any grant. We do not mean for one moment to infer that such institutions are not worthy of support, but the ordinary subscriber to a hospital fund does not include under that category either lunatic asylums or homes for incurable or dying patients. If, however, we exclude the above institutions from our calculations, how are Mr. Coleridge's figures affected? The facts are these: that (taking Mr. Coleridge's remaining figures as correct) hospitals with medical schools and laboratories attached received 5*l*. 8*s*. 9*d*.; hospitals with no medical schools, but connected in the special sense of the pamphlet with vivisectors, 4*l*. 14*s*. 2*d*.; and hospitals entirely unconnected with vivisection, 5*l*. per bed. In other words, while hospitals connected with medical schools received by a small amount the most per bed, those hospitals which were entirely unconnected with vivisection received more than those to the staffs of which so-called vivisectors were attached. There is, therefore, so far as the grant per bed is concerned, no ground for Mr. Coleridge's charges.

If we look into the matter more minutely we shall see that in the details of each hospital grant there is even less reason to suspect that vivisection had anything whatever to do with it. If we compare the maximum grants per bed in the hospitals as classified by Mr. Coleridge, we shall find the largest grant of all hospitals connected with vivisection laboratories was 8*l*., or approximately 8*l*., per bed, given to Guy's, a hospital in need of funds, and one, of course, doing magnificent work. If we take two hospitals entirely unconnected with vivisection, we find in the case of the N.W. London Hospital a grant of 10*l*. per bed, and in the case of the Royal Free Hospital a grant of 9*l*. per bed. How can it be argued, in the face of these figures, that preference was given to hospitals connected with vivisection *qua* vivisection? We do not wish to impugn Mr. Coleridge's motives, but the ingenious way in which he has attempted to mislead the charitable layman by the pamphlet before us is, in our opinion, in the highest degree reprehensible.

The end of this document in which truth is so distorted is devoted to a personal defamatory attack upon Lord Lister. This attack, we are pleased to see, is somewhat modified for the better since we last reviewed it; concerning it we must refer the reader to our former article. The monograph concludes with an epilogue consisting of a repetition of an invective, couched in Mr. Coleridge's most offensive terms, against science, and sounds like some papal bull of the middle ages anathematising that knowledge which was eventually to liberate mankind from filth, superstition, suppression and ignorance. Medical science, which perhaps has done more than any agency under Heaven to alleviate the sufferings of mankind, is ruthlessly termed "malignant." Invective is not argument, neither is calumnious opprobrium logic.

The charitable subscriber to London hospitals will see to what "diversion" his subscriptions will be subject if he follows the advice of Mr. Coleridge. It is to be hoped, and indeed to be expected, that he will give as he has done before, leaving the disbursement of his bequests to representatively elected committees of experts who, neither prompted by political motives nor influenced by misplaced and maudlin sentimentality, will assuredly allocate them to the most urgent wants of the sick.

THE PROPOSED BRITISH ACADEMY.

THE following text of the petition presented to the Privy Council by the council of the Royal Society in favour of the establishment of a British Academy appeared in the *Times* of February 27:—

TO THE KING'S MOST EXCELLENT MAJESTY IN COUNCIL.

The humble petition of the President and Council of the Royal Society.

Showeth—

That your petitioners pray that the petition which has been presented to His Majesty in Council praying for the grant of a charter of incorporation to "The British Academy for the Promotion of Historical, Philosophical and Philological Studies" be granted.

Your petitioners are led to take this step both for the general reason that the granting of such a charter will, in their opinion,

be for the great good of learning, and also for the special reason set forth in the following statement:—

In 1899 an International Association of Academies, composed of the leading learned bodies of many countries, was formed, the Royal Society taking an active part in its formation. Since the various studies cultivated by the constituent academies could be readily divided into two categories—(1) those of mathematical, experimental and natural science, and (2) those of philology, history and philosophy—the association established within itself two sections, one for the former the other for the latter studies, and drew up statutes in accordance with this division.

The Royal Society is, at the present time, concerned with studies of the former category only; and since no other learned body of the United Kingdom dealing with the studies of the other category belongs to the association, it has come about that while most other countries are represented in both sections, either by two academies or by an academy taking charge of studies of both categories, this country is represented in one section only.

In other words, in this country there does not exist, as in most other countries, an academy or other organisation of the rank of the several academies constituting the association in question, charged with the duty of fostering studies of the second category. The Royal Society, therefore, thought it to be its duty to bring this fact, regrettable on general grounds, quite apart from representation in the International Association of Academies, to the notice of certain persons in this country eminent in those studies.

A correspondence with these eminent persons resulted in the Royal Society being invited to consider how this regrettable state of things could be remedied, and in particular whether the Royal Society was able and willing to include the studies in question within its sphere of action.

The president and council of the Royal Society appointed a special committee to consider and report upon the matter, instructing the committee not to advise the president and council as to what action the society should take, but simply to state the reasons for and against the several suggestions put forward in the correspondence above mentioned.

The committee after prolonged investigation and consideration made a report of the desired character, stating incidentally its opinion that under the charters of the society the studies in question could, if it were deemed desirable, be taken charge of by the society itself.

The report of the committee was discussed at a special meeting of the Fellows, and the president and council, after carefully considering the report and the discussion at the above meeting of Fellows, adopted a resolution to the effect that they were of opinion that the studies in question ought to be taken care of by some academic organisation, and that this should be effected, not by the Royal Society taking charge of these studies, but by the establishment of some other body.

The president and council believe that the proposed academy, for which a petition has been presented, may with confidence be expected to take care of and promote the studies in question efficiently and successfully. They have reason to think that the establishment of an academy taking charge of such studies will be welcomed by all the constituent academies of the association, and they are prepared to offer it if established the cordial and friendly support of the Royal Society.

They therefore respectfully urge that the petition be granted.

And your petitioners will ever pray.

NOTES.

THE Croonian lecture of the Royal Society will be delivered on Thursday, March 13, by Prof. A. Gamgee, F.R.S., on the physico-chemical properties of hæmoglobin, its compounds and derivatives.

THE seventy-second annual meeting of the British Association will be held at Belfast on September 10–17, under the presidency of Prof. James Dewar, F.R.S. The presidents of the sections will be as follows:—A (mathematical and physical science), Prof. J. Purser; chairman of department for astronomy and cosmical physics, Prof. A. Schuster, F.R.S.; B (chemistry), Prof. E. Divers, F.R.S.; C (geology), Lieut.-General C. A. McMahon, F.R.S.; D (zoology), Prof. G. B. Howes, F.R.S.; E (geography), Colonel Sir T. H. Holdich, K.C.B.; F (economic science and statistics), Dr. E. Cannan; G (engineering), Prof. J. Perry, F.R.S.; H (anthropology), Prof. A. C. Haddon, F.R.S.; I (physiology), Prof. W. D. Halliburton, F.R.S.; K (botany), Prof. J. Reynolds Green, F.R.S.; L (educational science), Prof. Henry E. Armstrong, F.R.S. The evening discourse on September 12 will be delivered by Prof. J. J. Thomson, F.R.S., on "Becquerel Rays and Radio-activity"; and the discourse on September 15 will be on "Inheritance," by Prof. W. F. R. Weldon, F.R.S. The lecture to the operative classes, on September 13, will be by Prof. L. C. Miall, F.R.S, on "Gnats and Mosquitoes."

M. BAILLAUD has been elected a correspondant of the section of astronomy of the Paris Academy of Sciences in succession to the late M. Souillart.

ONE of Prof. J. C. Ewart's zebra-pony hybrids will be exhibited next week, March 13 and 14, in the Agricultural Hall, Islington.

THE Right Hon. R. W. Hanbury, M.P., President of the Board of Agriculture, has appointed a departmental committee to inquire into and report as to the present position and future prospects of forestry and the planting and management of woodlands in Great Britain, and to consider whether any measures might with advantage be taken, either by the provision of further educational facilities or otherwise, for their promotion and encouragement. The committee consists of Mr. R. C. Munro-Ferguson, M.P. (chairman), Sir John F. L. Rolleston, M.P., Mr. E. S. Howard, C.B., Prof. W. Schlich, C.I.E., Colonel F. Bailey, R.E., Prof. J. R. Campbell, Mr. J. H. Lewis, M.P., Mr. George Marshall and Dr. W. Somerville.

MR. R. H. TIDDEMAN, M.A., F.G.S., who joined the staff of the Geological Survey, under Murchison, in 1864, has just retired from the public service.

A MEETING of the Engineering Standards Committee was held at the Institution of Civil Engineers on March 4, to hear evidence on the question of the standardisation of locomotives and the specifications for the materials used in their construction. The questions down for consideration were:—(1) Is it desirable to proceed with the standardisation of locomotives? (2) If so, should this be a question of general design or only of component parts? (3) How far would it be of practical value to have standard specifications defining the quality of the materials used in locomotive construction?

ON Tuesday next, March 11, Prof. E. B. Poulton, F.R.S., will deliver the first of a course of two lectures at the Royal Institution, on "Recent Researches on Protective Resemblance, Warning Colours and Mimicry in Insects." The Friday evening discourse on March 14 will be delivered by Prof. Silvanus P. Thompson, his subject being "Magnetism in Transitu"; the succeeding discourse on March 21 will be given (in English) by Geheimrath Prof. Otto N. Witt, of Berlin, on "Recent Developments in Colouring Matters."

THE annual dinner of the Royal School of Mines was held at the Hotel Cecil on Friday last, Mr. Bedford McNeill being in the chair. In proposing "The Mining and Metallurgical Industries," the chairman alluded to the magnitude of the two industries connected with their profession, and said that mining in the past had been largely carried on by men who did not have the advantage of educational facilities, who had to learn largely, if not solely, in the school of experience. In spite of the improvement which had been effected in Cornwall, it had to be admitted that the conditions of practical mining in Cornwall were not fully representative of those higher developments which had been achieved in our colonies and in foreign countries. Mr.

W. Whitwell, in responding, spoke of the severe competition which the iron trade was experiencing in America, and attributed the success of the American iron trade in a great degree to the opportunities afforded in that country for education.

A FEW of the items in the Civil Service Estimates for the year ending March 31, 1903, are of interest in their connection with science and education. In the class of Salaries and Expenses of Civil Departments, the estimate for the Board of Agriculture, England, is 5378*l.* less than last year, but the Department of Agriculture, Ireland, has an estimate increased by 17,439*l.*, of which 4110*l.* is required for salaries and wages in connection with institutions of science and art, 300*l.* for the Royal College of Science for the purchase of books, specimens, &c., 1000*l.* for annual grants for science instruction, and 5800*l.* for grants in aid of day secondary schools. In the class of Education, Science and Art, there is a net increase of 235,446*l.*, of which extra amount the Board of Education will receive 170,884*l.*, while scientific investigation, &c., will obtain a net increase of 15,242*l.* The latter estimate includes an additional grant of 3000*l.* towards the cost of adapting and equipping Bushy House for the purpose of the National Physical Laboratory, this amount completing a total grant of 19,000*l.* There is also a grant of 16,000*l.* as the first instalment on account of a total sum of 42,000*l.* estimated to be required in a period of three years in connection with the international scheme for investigating problems connected with the fisheries of the North Sea and adjacent waters.

To celebrate the election of M. Bouquet de la Grye to the presidency of the Paris Academy of Sciences, the Artistic Union of Auvergne has had a medal designed and struck, and it was presented to him with an album containing expressions of esteem at a banquet held on February 13. The face and back of the medal are illustrated in *La Nature*, and the views are here reproduced. Colonel Laussedat presided at the banquet and referred in appropriate terms to the numerous scientific investigations of his colleague, from his first work in hydrography and on the transit of Venus expedition to his researches on the influence of the moon and his great scheme for making Paris a seaport. In reply, M. Bouquet de la Grye expressed himself conscious of the honour done him by the Academy of Sciences, and gratified at the celebration of it by his friends.

Medal presented to M. Bouquet de la Grye.

THE three very interesting papers on electric shocks which were read before the Institution of Electrical Engineers last Thursday direct attention to a subject of which very little seems to be known from either the electrical or the physiological side. Mr. Aspinall quoted a number of cases in which death might have been expected, but did not occur, and formulated a list of pertinent questions to which definite and certain answers would be of the highest value. Mr. Trotter gave a practical demonstration that the liability to shock at 500 volts is very much less than is generally believed. With dry boots and clothes he showed that one could quite safely stand or lie on an earthed rail whilst handling a live conductor at 500 volts. In other words, it is quite safe to fall across the rails of, say, the Central London Railway provided bare skin does not touch *both* the earthed and the live rail. Unfortunately, in a case of accident one cannot arrange the conditions for safety, and, moreover, a sudden unexpected shock may have much worse effects than one taken carefully and deliberately. The discussion of the papers on March 13 is likely to be of great interest. What is, perhaps, most desirable is that some definite information should be forthcoming on how best to restore life in a case of apparent death from electric shock.

AN interesting account of the electrical manufacture of carbon bisulphide is given in a recent number of the New York *Electrical Review*. The furnaces consist of tall stacks which are filled with charcoal; sulphur is fed in at the bottom of the furnace and allowed to rise, when molten, as high up the electrodes as is considered advisable. The molten sulphur acting as an insulator, the height to which it rises serves to regulate the current. Carbon bisulphide vapour is led off at the top of the furnace. The plant consists of two furnaces, each having a capacity of 20,000 pounds per day. One furnace lies idle, for cleaning, &c., whilst the other is running; it is said that a furnace can be run continuously for several months. The power is derived from alternators direct-coupled to water wheels, and at present only half the available water-head is being utilised. The larger output obtainable when the full water-head is used is likely to be considerably in excess of the demand.

WE have received an attractive pamphlet from the Acheson Graphite Company (Niagara Falls), which contains some useful information and data relating to the electrodes which they manu-

facture. The electrodes are first made up in amorphous carbon, which is then converted to graphite by baking at a very high temperature in the electric furnace. It is claimed that the conversion to graphite is complete. These electrodes are especially suitable for electrolytic purposes on account of their high conductivity and low porosity, and also, a recommendation which will appeal to experimentalists, on account of the ease with which they can be machined and worked. It is also not unlikely that the use of graphite electrodes in metallurgical processes will extend. Both in metallurgical and electrochemical work the quality of the electrodes is of the first importance, making in many instances all the difference between success and failure.

DR. C. JENSEN, of Hamburg, has contributed to the *Meteorologische Zeitschrift* for December last an interesting paper on the subject of atmospheric polarisation. The author reviews all the principal theories and discoveries from those of Arago in 1809 to the recent important works of Dr. Pernter relating to the analogy of various turbid media with the blue light of the sky. The author considers that the observation of atmospheric polarisation should be of use in weather prediction, as showing approaching cloudiness some hours before it is visible by other means, and also as showing whether the sky is clear or otherwise above a stratum of fog.

THE "campylograph" invented by Père Marc Dechevrens for mechanically describing certain ornamental curves is the subject of a paper by its inventor in *Cosmos* for February 22, and of a pamphlet, published in Brussels, by Père Potron, who deals with the equations of the curves it describes. The machine, to which the name campylograph is given, is an arrangement for compounding the projections, in two mutually perpendicular directions, of two circular motions, and as such it can be made to trace Lissajou's curves exactly, the amplitude of the component vibrations remaining constant instead of decaying as is the case with compound pendulums. Moreover, the table carrying the paper can be rotated and a variety of figures thus obtained, including the epicycloids and hypocycloids, and also curves similar to those given by a harmonograph with clockwork table, but without the gradual decrease in amplitude. It should, however, be remembered that numerous machines have at different times been designed for drawing various classes of ornamental curves, and it seems as likely as not that something practically identical with the "campylograph" may have been previously constructed.

SEVERAL papers tending to raise doubts regarding the well-known laws of electromagnetism for bodies in motion have already been noticed in these columns. M. R. Blondlot writes on this matter in the *Journal de Physique* for January. If a current of air is moving parallel to the axis of z in a magnetic field the lines of force of which are parallel to the axis of x, then, according to Hertz and Lorentz, an electromotive force ought to be set up in the negative direction of the axis of y, and if the two plates of a condenser are placed perpendicularly to this direction and connected by a wire so as to bring them to the same potential, they ought to become charged and to remain charged when they are separated. According to M. Blondlot, however, the only observable effects are such as can be accounted for by accidental causes, and are small in comparison with those required by theory. The author further remarks that by an application of the principle of action and reaction it would appear to follow that a displacement current in air exerts no magnetic action, and according to this view the discharge of a condenser is magnetically an open current. Or if this contradiction of Maxwell's theory be not admitted, we should have to abandon the principle of reaction.

THE spark spectra of those elements which are gaseous at ordinary temperatures have been extensively investigated, but little research has been hitherto done on the arc spectra of gases. Mr. O. H. Basquin has recently published, in the *Proceedings* of the American Academy of Arts and Sciences (vol. xxxvii pp. 161–174), an account of his research on "The Arc Spectrum of Hydrogen." In his apparatus, one electrode was made to rotate quickly, this preventing the welding together of the electrodes and also throwing the hot gases to one side. That part of the flame of the arc thus separated from the poles was very free from continuous spectrum, and he was thus better able to study the spectrum lines than if a stationary arc were used. The arc was enclosed in a comparatively air-tight brass "hood," through which a stream of electrolytically-prepared hydrogen was continually passing. The light from the arc passes through a lens fixed at the end of a brass tube fitting into the wall of the hood. The arc spectra in hydrogen of aluminium, copper, magnesium, coin-silver, sodium, tin and zinc were examined both visually and photographically. Of the well-known series of hydrogen lines seen in its low-pressure spark spectrum and in the spectra of the hotter stars, $H\alpha$ and $H\beta$ are well shown visually in the case of all metals except Na; the majority also show $H\gamma$, but $H\delta$ is rarely seen. $H\alpha$ is sharp and well defined, the others broad and hazy. In the photographic spectra, $H\beta$ and $H\gamma$ are seen in the case of all metals except Na, while $H\delta$ shows in the spectra of tin, silver and copper. A small dispersion spectrum of tin shows $H\epsilon$ also. The weaker hydrogen lines more refrangible than $H\epsilon$ have not been traced, this being probably due to the inordinate width of the lines, those detected averaging about twenty-five tenth metres. All the metals except tin give a characteristic set of lines which do not occur in the arc spectrum in air of the corresponding metal. These new lines do not seem to bear any particular relation to the spark lines of the respective metals, and the author supposes them to be due to compounds of hydrogen with the metals formed in the arc. No new lines have been found which can with certainty be attributed to hydrogen. At the end of the paper an interesting discussion is given of the general effects of the hydrogen atmosphere on the arc and its spectrum.

THE first of the international balloon ascents for the current year took place on January 9. At Chalais-Meudon the ascent was at 8h. a.m.; temperature at starting 1°.C., maximum height reached 11,405 m., minimum temperature −63°·1. At Trappes two ascents were made; the heights reached were 15,000 m., temperature −61°·4, and 15,670 m., −62°·2. At Strassburg a height of 8100 m. was reached; temperature at starting −4°.4, minimum −42°·8. One of the manned balloons at Berlin remained up for nearly twenty-nine hours, and the following readings were taken:—at starting, 3°·9; at 3490 m., −4°·3; at 4850 m., −15°·1. While travelling eastward the same stratum of cloud was always observed, the upper edge of which continually increased in height. Above the cloud an inversion of temperature occurred and a sudden change of wind from west to about north-west. Three balloons ascended from Vienna; in one of the manned balloons a temperature of −10° was recorded at 4100 m. Ascents were also made from Pavlovsk (St. Petersburg) and Mr. Rotch's observatory, Blue Hill, in the United States. Except at St. Petersburg, the balloons ascended in an extensive area of high barometric pressure, the centre of which lay over the Alps.

IN *Symons's Meteorological Magazine* for February, a map is given showing the places, so far as at present ascertained, at which deposits of yellowish-pink dust were observed on January 22 and 23. It attracted attention over practically the whole of Cornwall, near the western border of Devon, and at a few points in Somerset, the south of Gloucester and Glamorgan.

Specimens of the dust have been microscopically examined by competent authorities, and it appears to be of the same nature as that which is often carried over from Africa to Europe. Further particulars are needed for the purpose of a more detailed account. Dr. H. R. Mill gives some particulars respecting the high barometer readings of January last. The highest pressure before recorded in the British Isles was 31·108 inches, at Ochtertyre, on January 9, 1896, but the reading at Aberdeen on January 31, namely 31·11 inches, as given in the *Daily Weather Report*, was apparently a trifle higher than the previous record. Dr. Mill directs attention to the fact that the popular belief that a high barometer involves calm weather was somewhat rudely shaken by the easterly gale which raged in the Channel from January 31 to February 2—under the influence of the low-pressure area in southern Europe.

THE September issue (vol. vi. art. 1) of the *Bulletin* of the Illinois State Laboratory contains the first part of a history of the dragon-flies of that State by Messrs. Needham and Hart. The authors state that these insects, together with their near relatives the May-flies, are the isolated remains of an extremely primitive group, the members of which have become specialised along certain lines.

WE have received from the author, Mr. F. Finn, a copy of an interesting paper on the cage-birds of Calcutta, which appeared in the *Ibis* for July last. The taste for keeping birds in confinement has been prevalent for centuries among the natives of India, although now somewhat on the decline, the author citing evidence to show than an Australian cockatoo was imported in the time of Jehangir. It is satisfactory to learn that, on the whole, the treatment of these cage-birds is good. The natives display especial capacity for keeping soft-billed insectivorous species in confinement; and as an instance of the interest taken in birds, the author mentions that when a living bird-of-paradise was for the first time received in Calcutta, the then Amir sent a special messenger all the way from Cabul to ascertain whether it was really the bird he knew so well by report.

IN the course of a description of a new "agricultural ant" of the genus Pogonomyrmex, published in the *American Naturalist* for February, Prof. W. M. Wheeler takes occasion to dispose, once and for all, of the myth that certain ants of this group sow and reap the so-called "ant-rice." If the nests of the species in question be observed at the proper season, it will be seen that the workers often carry out from the store-chamber grains of ant-rice which have sprouted to deposit them in a heap some distance off. These seeds frequently, of course, take root and grow, and since the ants feed mainly upon such grass-seed, it is no matter for surprise that "ant-rice" should predominate in the ring of vegetation surrounding the nest. To state, however, that the ant, "like a provident farmer, sows this cereal and guards and weeds it for the sake of garnering its grain is as absurd as to say that the cook is planting and maintaining an orchard when some of the peach-stones she has thrown into the yard chance to grow into peach-trees." The myth will, however, probably be hard to kill, since it is supported, not only by the authority of Darwin, but is repeated in Lord Avebury's well-known work on ants.

THE oviparous species of peripatus form the subject of a long article (illustrated with a coloured plate) by Dr. A. Dendy in the February number of the *Quarterly Journal of Microscopical Science*. The fact that an Australian species of peripatus (using this term in a general sense) lays eggs was announced by Dr. Dendy in NATURE of February 14, 1889; and although, largely owing to some confusion in the identification of species, the statement was received with considerable scepticism, the author has now been enabled, not only to fully demonstrate its truth, but to show that the phenomenon occurs in a second Australian species. It is certainly a very remarkable circumstance that while the other known species of these primitive arthropods are viviparous, these two forms (now designated Oöperipatus) should lay eggs; and it would be of the greatest interest could the reason for the departure from the general rule be accounted for. Dr. Dendy, after describing the anatomy of the egg-laying species in considerable detail, discusses the phylogeny of the whole group.

TO the same journal Messrs. Bradford and Plimmer communicate an important paper on the organism infesting the blood of animals suffering from tsetse-disease. This parasite, for which the authors have proposed the name *Trypanosoma brucei*, is fully described and its life-history sketched. Many experiments have been made with the view of discovering whether any animals are immune against this parasite, but so far without success. The authors add, however, that there is probably in all animals some attempt at resistance to its attacks, and that this is effected by means of phagocytes. The parasite is closely allied to one affecting sewer-rats, which belongs to the same genus. The rat Trypanosoma does not, however, in the least protect the animal containing it against the tsetse parasite. It may be added that a beautiful series of greatly enlarged models illustrating the life-history of the latter is now exhibited in the Natural History Museum.

IN the last *Bollettino* of the Italian Seismological Society (vol. vii. No. 5), Dr. Cancani describes an interesting series of earthquakes felt during April and May, 1901, in the district round Palombara Sabina, near Rome, the strongest of which (on April 24) caused some damage to buildings. The focus of this earthquake being evidently at a very slight depth, Dr. Cancani ascribes the shocks to readjustments of the superficial strata due to the erosion of the underlying rock. From records obtained at Rome, Padua and Casamicciola, the mean velocity of the earth-waves was found to be 4·85 km. per second.

THE *Journal of Geography*, a new American monthly, succeeds the *Journal of School Geography* and the *Bulletin* of the American Bureau of Geography. The January number contains a paper on useful products of the century plants, by W. B. Marshall, and the first instalments of papers on field work in physical geography, by Prof. W. M. Davis, and on the trade and industries of western South America, by Emory R. Johnson. A special feature is "Geography Current," a series of notes and reviews on subjects bearing on various branches of geography.

THE *Journal* of the Society of Arts for February 14 contains a valuable paper by Commander R. Whitehouse, R.N., on the Uganda Railway and the survey of Lake Victoria Nyanza. On the opening of the whole line, the journey from Mombasa to Port Florence will take two and a half days, and the steamer journey from Port Florence to Mengo another day, as against seventy days by caravan. The railway has already opened up a large amount of country, and until other railways are constructed it must command the trade of the whole of that part of Central Africa.

THE Berlin Gesellschaft für Erdkunde begins the year with a change in the form of its publications. The *Zeitschrift* and the *Verhandlungen* are now combined in a single journal, which retains the name of the former, and is to appear ten times a year. The January number contains, among other things, papers by Herr O. Neumann, on a journey from the Somali coast through southern Ethiopia to the Soudan, by Herr K. Sapper, on the physical geography of Honduras, by MM. E. Reclus and Valère Maes, on the "disque globulaire" (the

admirable maps on natural curvature produced recently under M. Reclus' direction), and a report by Dr. E. von Drygalski, dated Cape Town, on the progress of the German South Polar Expedition.

THE Queensland Geological Survey, under the direction of Mr. William H. Rands, has forwarded *Bulletins* Nos. 13 to 17 (1901). In these we have additional notes on the Cretaceous fossils of Queensland by Mr. Robert Etheridge, jun., and reports on mining districts by Mr. Rands and Mr. B. Dunstan. Referring to the Mount Morgan mine, Mr. Dunstan remarks that it is impossible to tell by appearances whether the stone is rich or poor, as of two samples which might be absolutely the same in texture, colour, structure, specific gravity and visible mineral constituents, one would perhaps yield as many ounces of gold to the ton as the other would pennyweights. In an account of Diglum Creek, in the Gladstone district, Mr. Dunstan describes the production of garnet, wollastonite, epidote and chert where granite has come in contact with limestone. We have also received folio reports on the Gympie gold field by Mr. Rands, and on the Hamilton, Coen and Jordan Creek gold fields by Mr. Lionel C. Ball. Permo-Carboniferous coal-bearing beds occur in the valleys of the Dawson and Mackenzie rivers, and outcrops of anthracitic coal have been traced by Mr. Dunstan. The Dawson coal, which is a ten-foot seam, is reported to be suitable for general purposes and as absolutely smokeless. In central Queensland there is an area of upwards of 5000 square miles which may be coal-bearing; hence a closer and more detailed examination of this region is desirable.

MESSRS. CASSELL AND CO. have commenced the publication, in fortnightly parts, of "Familiar Wild Flowers," by Mr. F. E. Hulme The complete work contains 280 coloured pictures, including 40 which have been specially prepared for the new edition, and will be completed in twenty-four parts at sixpence each.

MR. W. WESLEY, of Essex Street, Strand, sends us a "Catalogue of Zoological Literature" (No. 140, in two parts). As it includes the late Mr. S. P. Hanley's conchological library, as well as the entomological library of Mr. H. Christoph and the works on Cœlentera collected by the late Prof. G. J. Allmann, it is worth careful attention on the part of those interested in such subjects.

MORE than forty years after his first determinations of the transport numbers of the ions in the passage of electricity through solutions of electrolytes, W. Hittorf describes, in the *Zeitschrift für physikalische Chemie*, some interesting experiments relating to the influence, exercised by the diaphragms separating the anode and kathode solutions, on the measured values of these transport numbers. When a porous clay diaphragm is used, the volume of the solution at the anode decreases in all cases investigated. When, however, an animal membrane separates the anode and kathode solutions, it is found that with solutions of the chlorides of potassium, ammonium and sodium, cataphoresis takes place in the direction of the current, whilst with dissolved chlorides of the alkaline earth metals and of cadmium, the cataphoric effect is in the opposite direction. In the latter case, the volume of the solution at the anode increases. At the animal membrane, apparently a separation of the original solution into a solution more concentrated and one more dilute takes place. This behaviour of animal membranes results in considerable errors in the determination of transport numbers, and Hittorf is able to account for the deviations between the results obtained by himself in the late fifties and those more recently obtained by other investigators who have not made use of animal membranes in their experiments.

THE additions to the Zoological Society's Gardens during the past week include a Pluto Monkey (*Cercopithecus leucampyx*, ♂) from Uganda, a Leopard Tortoise (*Testudo pardalis*) from British East Africa, presented by Major C. Delmé Radcliffe a Vulpine Phalanger (*Trichosurus vulpecula*) from Australia, presented by Mr. T. W. Dye; three Bengal Red-vented Bulbuls (*Pycnonotus bengalensis*) from India, presented by Mr. Frank Finn; a Ludio Monkey (*Cercopithecus ludio*) from West Africa, two young Lions (*Felis leo*, ♂ ♀) from British East Africa, four Prjevalsky's Horses (*Equus prjevalski*, ♂ ♂, ♀ ♀) from Mongolia, a Red Lory (*Eos rubra*) from Moluccas, a Green Conure (*Conurus leucopthalmus*) from Trinidad, an Angulated Tortoise (*Testudo angulata*) from South Africa, deposited; an English Wild Cow (*Bos taurus*) born in the Gardens.

OUR ASTRONOMICAL COLUMN.

THE SPECTRUM OF THE CHROMOSPHERE.—At the recent meeting of the Astronomical and Astrophysical Society of America, held at Washington, Mr. S. A. Mitchell read a paper on the observations made during the total solar eclipse in Sumatra on May 18, 1901. The spectrum photographs were obtained with an objective grating spectrograph; the grating had a ruled surface $3\frac{1}{2} \times 5$ inches, with 15,000 lines to the inch, the objective being a quartz lens of a little more than $3\frac{1}{4}$ inches aperture and about 72 inches focal length. Light from the eclipsed sun was reflected into this instrument by a cœlostat. The adjustments were such as to ensure a "normal" spectrum, this being the case when grating and photographic plate were each perpendicular to the diffracted beam. The first order was employed, from λ 3000 to λ 6000. Although the sky was never clear during the period of totality of 5 min. 41 secs., eight exposures were made—one before and one just after totality for the cusp spectra, one at first and one at second flash, and four with varying exposures during the total phase. The second flash appeared fully exposed, and the plate has been carefully measured. The dispersion is such that from $H\beta$ to $H\epsilon$ occupies a length of 95·4 mm., *i.e.* 1 tenth-metre corresponds to about 0·1 mm. In the region mentioned, $H\beta$ to $H\epsilon$, 363 lines have been determined. Of these, 269 have been identified with lines on Rowland's map.

Tables have been made of the ratios between the intensities of lines in this flash spectrum and in the ordinary Fraunhofer spectrum, and also of the ratios of the number of lines of each element identified to the whole number of solar lines for that metal. Both these sets of ratios appear to show systematic variation, and they are grouped into three classes, their behaviour being considered in conjunction with the atomic weights of the elements.

The variations in intensity are considered as chiefly due to the various heights to which the different metals ascend in the chromosphere. It is thought that the metals of group II. extend very high and are nowhere very condensed, and their flash lines will be true reversals of the corresponding solar lines. The metals of groups I. and III. are denser near the sun's surface and do not extend so high, and hence their flash lines are to be regarded as only partial reversals of the Fraunhofer lines. These facts lead the author to conclude with a renewal of faith in the existence of the "reversing layer."

PHOTOGRAPHIC DETERMINATION OF LONGITUDE.—In the *Comptes rendus*, vol. cxxxiv. pp. 387–389, M. G. Lippmann describes a new method for the photographic determination of longitude, using an apparatus originally designed by M. Fabry (*Bulletin Astronomique*, p. 148, 1895) for visual observation only. The arrangement was extended by M. Lippmann so as to permit of photographic registration, and described in *Comptes rendus*, cxxxiv. pp. 205–208. The principle of the method consists of making simultaneous records of the zenith at each station, the required longitude being the difference in right ascension observed. The apparatus is similar to that employed for nadir observations. Light from an adjustable horizontal collimator falls on a half-silvered mirror inclined at 45° to the vertical, and is reflected to the surface of a bath of mercury. After its reflection from the mercury, the light is again reflected from the mirror into the collimator, giving an image of the slit or cross-wires which may be adjusted to coincide with the source.

When this is done, a telescope is employed to photograph the region about the zenith as reflected from the upper surface of the silvered mirror. In this position the photographic telescope will lie in the same direction as the fixed collimator, and thus it can be arranged to have a suitable exposing screen, by which, at any instant, a short exposure is given to a strong light placed near the collimator slit, which will give an image of the slit superposed on the region near the zenith, the centre of this image indicating the instrumental zenith. All that remains to be done is to provide a duplicate apparatus at a second station, and by operating the exposing shutters of their respective collimators by electric means, the zenith of each place will be automatically recorded. The difference of longitude between the two stations will be equal to the difference of the right ascensions of the two collimator images. The chief corrections will be owing to the possible prismatic form of the reflecting mirror and the catalogue errors introduced in computing the right ascensions.

INDIAN SURVEYS.[1]

THE Report on Indian Surveys for the year 1899–1900 is now before the public, and the resolution of the Government of India which concludes this report pronounces it to be one which reflects great credit on the "able and effective administration" of Colonel St. G. Gore, R.E., the present Surveyor-General. Field operations were carried on by one double and fifteen ordinary parties and four detachments. Eight of these parties were employed on topographical (including geographical) surveys, only one on trigonometrical work, and the remainder included cadastral and traverse surveys and special geodetic investigations. A large area of forest survey was also completed. The total outturn amounted to nearly 150,000 square miles, of which more than 120,000 square miles were "reconnaissance" or geographical surveys, on the ¼-inch or smaller scales, in Burma and on the north-west frontier. The total area of rigorous surveys on all scales was 29,418 square miles. The normal scale for topographical surveys in India is 1 inch = 1 mile, and the cost of these surveys (which are based on rigid triangulation) is from 25 to 30 rupees per square mile—a cost which compares favourably with that of American surveys conducted under similar physical conditions, but with a very different staff of employés. The cheapness of Indian surveys is doubtless due to the general employment of skilled native labour. In this connection it is satisfactory to note that natives are now being instructed to triangulate and that the magnetic party which has been lately inaugurated will be placed under a native observer.

The general increase in the outturn on that of the previous year is due to the accession of an unusually large area of geographical mapping, full details of which are not published. Topography, conducted on rigorous methods, was chiefly confined to Burma and Sind, two countries which, whilst they balance each other geographically on the east and west, afford a useful contrast for comparison of cost rates and methods of survey. Of the special work undertaken by the Department, that which resulted in a comparison of the values of level deflection by means of observed latitudes on Great Arc stations receding gradually from the Himalaya is most instructive, and special attention is called by the Government of India to Captain Lenox Conyngham's discussion of the results obtained. Experiments were made with the Bridges-Lee photo-theodolite, and with the Jaderin base measuring apparatus which promises, if not to supersede the complicated adjustment of compensation bars altogether, at least to simplify the process of measuring bases for all but the most rigidly accurate geodetic purposes. The former is pronounced to be a very promising auxiliary to the plane table (especially in mountainous countries), "but it will never supersede it." This, it may be remarked, is nearly coincident with the opinion of Canadian surveyors who have tested photo-topography far more exhaustively than has been done in India. As regards the Jaderin apparatus, an unfortunate uncertainty about the value of the coefficients of expansion in the metals forming the tape has deferred an expression of opinion on its success or otherwise.

Record is made of a most useful invention in the printing office by a R.E. foreman which enables the process of photography to be eliminated from the cumbersome method of map reproduction by photo-zincography. There can be little doubt of the value of the invention, which is fully described, and which has been patented in India. It has already enabled the printing office to deal with a vast number of maps in excess of the normal outturn. We are glad to observe that the invention has met with prompt recognition by the Government of India. The report contains three or four excellent photogravure illustrations, one of which is a suggestive view of a railway bridge on the Mandalay-Kunlon line, which is now under construction.

The map illustration is perhaps the most unsatisfactory feature in the report. One map at the commencement of the volume purports to show the "progress of the Imperial surveys," and exhibits a special colour to denote "geographical reconnaissance on various scales." According to this map a large area of the Madras province has never even been "geographically reconnoitred"—which is a very astounding fact if it is true—for it is blank white paper. And the fact that no surveys are shown in Baluchistan must be due either to an affectation that British Baluchistan and Quetta have nothing to do with India, or else it is a deficiency in the illustration, for it leaves an enormous area of the outturn of the Department which is included in the body of the report absolutely unaccounted for. The triangulation chart adjoining shows a very satisfactory-looking series extending to Kandahar from the Indus, and another series reaching half way through Makrán. Triangulation usually carries topography on its back, and doubtless it does so in the present instance. Why the extent of transfrontier "geographical reconnaissance" (to say nothing of exact detailed topography) should not be shown in the chart it is difficult to imagine.

[1] General Report of the Operations of the Survey of India Department, 1899–1900.

MILROY LECTURES ON TYPHOID FEVER.

IN his second and third (final) lectures at the Royal College of Physicians, Prof. Corfield gave detailed descriptions of a number of outbreaks of typhoid fever which had been traced to specific contamination of drinking water, and exhibited a table which he had prepared demonstrating the fact that during the ten years 1891 to 1900 (with the exception of 1897) typhoid fever has been more prevalent in St. George's, Hanover Square, in November and December than in August, September and October, the months when it is normally prevalent, the average number of cases per month for November and December having been 7·2, and for August, September and October only 4·2. This excess of typhoid fever in November and December was coincident, he said, with the increase in organic matter in the water supplied by the Thames companies when the river was in flood. He pointed out that Mr. Shirley Murphy, the Medical Officer of Health of the London County Council, had drawn attention to the fact that in 1894 there was an excess of typhoid fever in November and December in the London districts supplied by all the water companies, except the East London and the Kent companies, and that this followed exceptional floods in the rivers Thames and Lea. Dr. Corfield stated that he was satisfied from these facts that the distribution of inefficiently filtered river water during November and December was the cause of the increase in the number of typhoid fever cases which occurred among persons especially liable to the disease.

Among the cases of polluted well water described by him, perhaps the most interesting and remarkable was one which he had recently investigated at a country house where there had been a case of typhoid fever, and where, by a peculiar arrangement of the suction pipes of a pump, water was, in certain circumstances, siphoned automatically from a pond polluted with the house sewage into the well supplying drinking water.

Dr. Corfield then described a number of outbreaks in which the poison of typhoid fever had been distributed by means of milk, oysters, cockles and mussels, ice-creams, ginger-beer, and even oranges and grapes, these fruits having been thrown, because they were decaying, into an ash-pit where typhoid excreta had been previously put, and having been picked up and eaten by a number of children.

Among the reports quoted were some from Belgium, France and Germany, kindly sent him by Dr. Kuborn, of Seraing-Liége, Dr. Brouardel, of Paris, and Dr. Pistor, of Berlin, respectively, and also some from different parts of the United States, and others by Dr. J. Ashburton Thompson, the President of the Board of Health of New South Wales.

In concluding his account of the communication of the disease

by foods, Dr. Corfield stated that in 1871 he was called on to inspect the house at which His Majesty (then Prince of Wales) was supposed to have contracted typhoid fever, and reported the results of his investigations in a letter which appeared in the *Times* of January 22, 1872, in which he showed that, although there were certain sanitary defects in the house in question, there were no such defects as had been previously described. For instance, it had been said that the water-closet in their Royal Highnesses suite of apartments was directly connected with a cesspool beneath them, and that its soil-pipe was not ventilated. Neither of these statements was true; there was no cesspool under the water-closet at all, nor, indeed, anywhere on the premises, and the soil-pipe was fully ventilated. There was, in fact, nothing the matter with that water-closet, and it is certain that His Royal Highness did not get his attack of fever from any foul air in it. There was, however, a defect in a water-closet in the middle of the house, and he was unable to say positively that the outbreak of the disease was not due to defective sanitary arrangements. On looking through his notes, made some thirty years ago, he had come to the conclusion that, although it was proved that the outbreak was not caused by water or milk, it was in all probability caused by some other food (such as oysters or salad) which was partaken of by His Royal Highness, the other gentlemen of the party and some of the menservants (among whom all the cases occurred), perhaps at a shooting luncheon, but not by the Princess of Wales, or by any of the other ladies or female servants. Had the outbreak been caused by the insanitary condition of the premises, it would certainly have attacked some of those who were most in the house, whereas it attacked those who were most out of doors and some of those who did not sleep in the house at all.

He then described cases in which the disease had been distributed by means of sewer air and by the washing and mangling of clothes. The questions of ground water and of direct infection were also considered. An account was given of the behaviour of the typhoid bacillus in various circumstances, and the lecture concluded with a reference to the prevalence of typhoid fever in South Africa and its probable dissemination by means of dust and flies, as well as by water, and with some tables of statistics showing the great diminution of the death-rate from the disease in England and Wales, and also in Paris, during recent years. The increase of the disease in Paris during the years 1899-1900 was not peculiar to that city, as it was shared by London and England generally, and it was only heard of because the Paris Exhibition was held in 1900.

EVOLUTION AND ITS TEACHING.[1]

EVER since the dawn of the human intellect, man has tried to increase his knowledge in two ways, by observation and by speculation. Observation came first, for that is common to man and animals. Speculation is a distinctly human attribute, and we find that it soon out-distanced observation, and formed the basis of the earlier philosophies. But during the last few centuries, the observational method has once more come to the front under the name of science, and its conclusions have not always been in accord with those of the speculative philosophies which preceded it.

The difference between the two methods is that whereas speculation starts a chain of reasoning from one or two propositions which are taken as absolutely true, science reasons from the basis of as large a number of observations as possible, and tries to find a hypothesis which connects them all together; or explains them, as it is usually called.

An Outline of Evolution.

The idea of evolution originated with the Greeks, but only as a speculation, which led to nothing; and its scientific history may be said to commence in the early part of the last century, when the practically new theory of the origin of species by gradual development was proposed by Lamarck. This theory was at first discredited for lack of evidence; but it was developed and demonstrated by Darwin in the middle of last century. About the same time it was pointed out by Lord Kelvin that not only was the sun cooling, but that all kinds of energy, when converted into heat, lost a portion by radiation into space, and that this process must go on until the whole universe was of a uniform temperature. So that, although the amount of energy in the universe remains unalterable, it will, by redistribution, be brought into the potential state, and thus, when every possible action is counterbalanced by other actions, energy will practically disappear.

From this theory of "dissipation of energy" it follows that as the earth is cooling, life cannot go on for ever; and also that at some former time the earth must have been too hot for the existence of protoplasm. Consequently, life can only have a limited existence on the earth. It must have had a beginning, and must come to an end.

But the inference extended further. Not only living beings, but even the whole solar system must have had a beginning, not indefinitely remote; because most of its members still contain a large amount of their original heat. And if the solar system had a beginning, so also must each star in the heavens have had a beginning; for the very fact that we can see them is a proof that they are radiating out energy. And, it was asked, why should not the whole universe, visible and invisible, have had a common origin and a common beginning in time? This had been the opinion of Immanuel Kant in the middle of the eighteenth century, and although modern astronomy has not altogether confirmed his speculations, it has proposed a hypothesis which is not very dissimilar. This is the "meteoritic hypothesis," and is chiefly the work of Sir Norman Lockyer and Prof. G. H. Darwin. I will give you a short sketch of the views held by the former.[1]

Inorganic Evolution.

The close connection between the orbits of comets and those of meteoritic streams has led to the universally admitted conclusion that comets are neither more nor less than swarms of meteorites. Again, the resemblance between the spectra of comets and those of nebulæ suggests that these also are swarms, or aggregations, of meteorites. And we naturally infer that the stars with similar bright-line spectra must be collections of meteorites. From bright-line stars we pass to those of which the meteoritic origin is no longer to be recognised, all having blended together. Further, it is claimed that by supposing variable and temporary stars to be due to the meeting and entanglement of two meteoritic swarms we get a better explanation of the observed phenomena than any other hypothesis can give.

This meteoritic hypothesis supposes that the present material universe was at one time in a state of "cosmic dust," spread irregularly through space, and moving slowly in many directions. It is the original irregular distribution of the cosmic dust and its irregular movements which are the source of all the energy in the universe. We have specimens of this cosmic dust in the chondroi, or spherules, of which many of the stony meteorites are built up. They are small round bodies of crystallised minerals, varying from microscopic dimensions to the size of a marble. Of course, these chondroi are not the first form in which matter existed. They are evidently due to chemical reactions, and we could frame several different hypotheses as to their origin and history. But these would be speculations which could not, at present, be verified, and so we must content ourselves with the chondroi as the earliest form of matter known to us.

Through the action of gravitation, much of the cosmic dust is supposed to have aggregated into meteorites, the irregular movements of which were, in certain places, reduced to order; and so arose a number of meteoritic streams, or swarms, moving through space. Still, under the force of gravitation, each of these swarms got more and more dense, until, at last, collisions took place between the meteorites; light and heat were given out, and the swarm became a nebula. The heat produced by the collisions would, at first, be slight, but would gradually increase, until the whole of the solid material was resolved into vapour and a star was formed. Concentration, however, would still go on, and the temperature of the star would rise until, in time, the loss by radiation more than counterbalanced the gain by concentration, when the star would begin to cool. At last light would no longer be given off, and the star would end by becoming a dark cold body moving in space. Of course, some stars would attain a higher maximum temperature than others, and either a single or a double star might be the result of the condensation; but all would follow a somewhat similar development.

[1] Abridged from an inaugural address, delivered before the Australasian Association for the Advancement of Science, by Captain F. W. Hutton, F.R.S., president, on January 8.

[1] See "The Meteoritic Hypothesis" (Macmillan, 1890); and "Inorganic Evolution" (Macmillan, 1900).

Now, as a matter of fact, the spectroscope shows us that stars in all these stages actually exist at the present day in the heavens. In some the temperature is increasing, in others it is decreasing, and, although small stars must run through their development quicker than large ones, this is quite insufficient to account for all the present differences. From which it follows that some of the stars are much older than others. The sun was amongst the earliest of formed stars. When it was born, the sky must have presented an almost uniform blackness. There was no Milky-Way; no Orion or Southern Cross; no Pleiades or Dog Star. All these, and many others, have been added since; not altogether, but one after the other, through the long ages during which the sun was undergoing development. Judging by the relative ages of the stars, it seems probable that the process of concentration of the original cosmic dust commenced near the solar system and spread outwards to the Milky-Way. But, however this may be, the process is not yet over. Many nebulæ have not yet condensed into stars. Swarms of meteorites still traverse space, and, even in the neighbourhood of the solar system, they are so abundant that the earth alone is estimated to collect more than twenty millions each day.

However, slow as the process of condensation is, it is not endless. In time all the meteoritic dust will be collected into stars or planets, and in time the law of dissipation of energy will bring all these bodies to a uniform temperature. So at last the movements due to the original unequal distribution of matter will cease and the life of the universe will come to an end. We know of no process of rejuvenescence by means of which dissipation of energy, and the force of gravitation, might be counteracted. Several attempts have been made to refute the theory of dissipation of energy, but all have failed. The ether which pervades space is the only part of the universe which shows no sign of evolution. It alone remains unchanged.

A casual glance at the stars gives us the impression of immutability. We still speak of the fixed stars in much the same way as our forefathers used to speak of the everlasting hills. But we know that they are not fixed. We know that the nearer stars, including the sun itself, are in swift movement; and we infer that all are so. But we can see no connection between their movements. Single stars, or small groups of stars, are rushing through space in various directions, and we cannot detect any common centre of gravity which holds them in control. The stars have not yet attained the regularity of movement that gravitation must bring about in a very ancient system, and this idea of the comparative youth of the universe is strengthened when we remember that large numbers of the primitive meteorites are still wandering in space uncondensed into stars. If it be true that the sun is one of the oldest stars in the universe, and if, as geologists think, the earth is not more than a hundred millions of years old, then it may very well be that the creation of the cosmic dust out of which the stellar universe has been formed took place less than two hundred millions of years ago. But although it may be possible to place a limit to the age of the universe, we can fix no time for its duration. It is impossible to form an estimate of the hundreds of millions of years that will pass before the end approaches. Still, a time must come when all energy will be equilibrated, and when, possibly, the visible universe may resolve itself into invisible, motionless ether.

In the solar system we can study the development of a meteoritic swarm in greater detail. Here we find that the whole of the meteorites did not collect into a single mass, but that several planets, as well as the sun, were formed simultaneously. It has been shown by Prof. G. H. Darwin that the effect of many collisions among a swarm of meteorites would be gradually to eliminate orbits of great eccentricity until, in time, a regular system would be developed, when the whole of the meteorites would travel nearly in the mean plane of their aggregate motions. The larger of the meteorites would tend to settle towards the centre, while other aggregations might easily occur at different distances from the centre. And of these the outer planets would be larger than the inner ones, because in the more distant regions, where the attraction of the central sun was less, the movements of the meteorites would be slower, and there would be a greater tendency to agglomeration than where the movements were more rapid. As meteorites contain but little oxygen, hydrogen, carbon, silicon and alkalis—substances which are all abundant on the surface of the earth—large numbers must have been fused together to form the earth, and the lighter substances must have collected near the surface. Consequently, the collisions between these meteorites must have occurred with sufficient rapidity to melt the whole mass. For after a solid crust had been formed, all the meteorites which fell on the earth would remain on the surface as they do now.

As with the solar system, so, also, in the earth itself we can trace distinctly a physical evolution. The discovery of tidal friction gave an independent proof that the earth had had a beginning not infinitely remote, for if that had been the case, the tidal friction would have reduced the time of the earth's rotation on its axis to that of the moon. Also we have sufficient geological evidence to show that not more than one hundred millions of years ago the earth was in a molten condition, and, probably, shone with its own light. As cooling went on, the silicates crystallised out, forming a solid crust over the still molten, metallic interior, the earth then becoming a dark body. At that time all the water above the crust was in a state of vapour which, subsequently, fell as hot rain, forming a boiling ocean. With this rain the denudation of the primitive crystalline rocks commenced, and their débris was deposited on the bed of the ocean as sedimentary rocks. Gradually the continents were formed, the new ranges of mountains following each other in orderly succession, the great oceans becoming narrower and deeper as well as more and more salt. These processes are still going on, but, as the earth is cooling, the internal energy which uplifts the mountains must be diminishing, and in time it will be insufficient to counteract the denudation. Then the whole of the land will be swept into the sea, and the waves of the ocean will roll over the surface of the earth unopposed; unless, indeed, before that time arrives the ocean should have been frozen into a mass of ice, or should have sunk slowly into the ground. All these things are approaching, but which of them will come first it is impossible to say.

Organic Evolution.

When, during the course of physical evolution, the ocean had become sufficiently cool for the existence of protoplasm, minute living organisms appeared on its surface. These increased in size, varied in many directions, and, in time, discovered the bottom of the sea, on which they established themselves, changing from swimming to crawling creatures. Gradually these organisms managed to live in safety among the rough waters of the sea coast, and then they spread over the land, first the plants and then the animals, which came to feed on the plants.

Once established on land and breathing air, improvements in the circulatory system of the higher animals became possible. The purified blood was kept separate from the impure blood, and increased rapidity of physiological processes heated the body, so that, in the birds and mammals, a stream of pure, warm blood was poured upon the brain. Thus stimulated, the brain developed rapidly, and the psychological evolution, thus inaugurated, has reached such a height in man as to place him mentally apart from the rest of the animal kingdom.

Biological evolution differs from physical evolution in being brought about by the transmission of bodily variations from one generation to another. And in psychological evolution, mind is transmitted from parent to offspring, as well as the organ in which it is to be manifested. Intelligence, however, depends, not only on the structure of this organ, but on early associations and education, by which means the wisdom of one generation is handed down to the next.

Psychological evolution consists of two parts. The first is intellectual, and is found in all the higher animals as well as in man. The second is ethical, and is exclusively human.

Intellectual evolution, like biological evolution, is due to competition between different individuals and the action of selection. We probably see the first germs of ethical evolution in parental affection, which, among gregarious animals of sufficient intelligence, widened into social sympathy, and this, in man, gave rise to the social or civic virtues.

This advance also appears to have been, or, at any rate, may have been, due to selection, and the result was the emergence of what is called utilitarian morality. Morality, in the strict sense of the term—that is, formal morality—also appears to have arisen from sympathy, but not by means of selection. The long and constant use by man of formal morality has made it instinctive, and has thus given rise to the conscience.

Secondary Causes.

When we think of the whole work that has been accomplished by evolution we are overwhelmed by its vastness. The results of organic evolution, particularly, are so marvellous that, to our

limited intelligence, the forces to which they are due seem to have been constantly directed in their course. The human mind is more disposed to accept the idea of guidance than that of predetermination, as it seems to us to be the less impossible of the two, and the more easy to understand. We ourselves wait upon circumstances; we see how things are going to shape before we move, and we fancy that the world must have been made, and must be carried on, on the same principle. But the study of nature gradually causes this belief to fade away. The more we learn the more we see that secondary law extends much further than we had expected, and we begin to think that all may be due to secondary laws.

We cannot doubt but that the most complicated cases of inheritance—such as the growth of the train feathers of a peacock, or the gorgeous wings of a butterfly—are due to secondary laws, although the processes are quite incomprehensible to us. We believe these to be due to secondary laws, because we see them taking place in exactly the same order over and over again; and in the case of the peacock we know that if we pull out the feathers, new ones, similar to the old, will replace them. So that we can bring these laws into play whenever we choose. It is not sufficient, therefore, to say that an action is not due to secondary law, because it is so wonderfully intricate, or because it is incomprehensible to us. We must be able to show, either that the action is antagonistic to known natural laws, or that the result could not be due to a combination of any natural laws that we have already discovered. That is, we must show a discontinuity in the phenomena. Can any such breaks be discovered?

The origin of the material universe, which was the starting point of the present evolutionary process, appears to us to have been a new departure in natural law. But we cannot feel certain about it, for we do not know, and never can know, what went before. But with the origin of life on the earth it is different. The intimate structure of organic beings, as well as their order of development on the earth, point to the conclusion that they are all derived from a common ancestor, and that living protoplasm was formed once, and once only, on the surface of the sea. Now, in the origin of living substance on this planet we have a case which is generally recognised as a break in continuity. It is generally allowed that it was an action which is not only incomprehensible by us, but one which conflicts with our knowledge of natural laws. That an unstable chemical compound, endowed with the power of directing energy independently of any outside agent, should have been brought into existence by the action of known physical laws is an impossibility. The processes of assimilation and fission, on which all progress depends, are quite distinct from anything which had gone before. And as every living cell is imbued with what we call instinct, which directs its energies, it follows that in physiology action and reaction are not equal and opposite. Indeed, every organism inherits from its parents a store of energy which directs growth and which appears to be inexhaustible. It is drawn upon during the whole period of growth, which, in some plants, lasts all through life, and yet abundance is left for transmission to its offspring, no matter how numerous they may be. The store increases instead of diminishes, and we cannot tell why. Until some explanation can be given, it is not only permissible, but reasonable, to view the origin of life as due to some guiding action of natural law, especially when we remember what that break in continuity has led to.

Again, it has been often pointed out that the genesis of consciousness is as great a mystery as the genesis of life, and that it seems to be equally opposed to the law of conservation of energy. In the lower animals, and in some of the lowest plants, we see physiological processes producing movements which appear to be intelligent, but which, in reality, are no more so than the movements of the leaves of a sensitive plant. And it is generally allowed that for the exhibition of consciousness a brain-cortex is required; but how matter in the brain-cortex becomes self-conscious we cannot understand. However, it is possible to suppose that mind is a necessary concomitant of life, so that the origin of the two may be one and the same problem. Also, as consciousness may be lost—as in habit—and regained by attention, it is possible that consciousness may be a constant function of mind, but one that cannot become efficient until a large number of specially formed cells are accumulated in a brain-cortex. I cannot, therefore, see that the genesis of consciousness in animals necessarily marks a break in continuity, notwithstanding that its origin is quite incomprehensible to us.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

CAMBRIDGE.—Proposals have been laid before the Senate for modifying the principles of classification in the natural sciences tripos, though the proposals are not unanimously acquiesced in by the boards concerned. In part i., in which at present the aggregate mark in three or four sciences governs the class, it is suggested that weight should also be given to the candidate's particular performances in each subject. In part ii., a candidate is required, for a first class, to take at least one primary and one subsidiary subject; it is proposed to abolish the requirement of a subsidiary subject. It is further proposed that human anatomy and vertebrate comparative anatomy should in future be reckoned as a single subject in this part of the tripos. These changes, if approved, are to come into effect in 1904.

Earl Spencer, K.G., has been appointed an elector to the professorship of agriculture in the place of the late Sir J. H. Gilbert, F.R.S.

UNDER the will of the late Dr. Nathaniel Rogers, the Senate of the University of London offer a prize of 100*l*., open for competition to all the members of the medical profession in the United Kingdom, for an essay on "The Production of Immunity in Specific Infective Diseases—generally, and with particular Reference to any one Disease on which the Writer of the Essay may have made Original Investigations." Essays must be sent in not later than February 28, 1903, addressed to Mr. Percy Wallace, secretary to the Senate.

THE report of the executive committee of the Carnegie Trust for the Universities of Scotland on the administration of the trust for the period from June 7, 1901, to December 31, 1901, was read and passed at a meeting of the trustees last week. For the winter session 1901–2, the sum of 22,941*l*. 16*s*. 6*d*. was paid by the trust up till December 31, 1901, on behalf of 2441 students, representing the fees of 7610 classes. The committee, in accordance with the expressed desire of Mr. Carnegie, did not make question respecting the circumstances of applicants; but from information voluntarily offered by applicants themselves, they have ample assurance that in a large number of cases the payment of class fees has proved a boon of the greatest value to deserving students, and many acknowledgments of the letter sent to the parents and guardians of applicants express gratitude for the timely assistance rendered by the Trust. The class fees paid and the number of students were as follows:—St. Andrews, 268 students, class fees, 2452*l*. 16*s*.; Glasgow, 828 students, class fees, 7672*l*. 13*s*. 6*d*.; Aberdeen, 473 students, class fees, 3806*l*. 1*s*. 6*d*.; Edinburgh, 872 students, class fees, 9010*l*. 5*s*. 6*d*.

MR. J. H. GARTSIDE has given to the Owens College, Manchester, the sum of 10,000*l*., which has been applied in the purchase of an annuity of 1163*l*. a year for ten years, payable to the college, to be used for the provision of scholarships, which are to be known as "The Gartside Scholarships of Commerce and Industries." The scholarships are intended to induce young men who have already received a good education to devote a year at least in Owens College to the special study of subjects bearing on commerce and industry, and then to go abroad for the study of some particular subject, either in Germany or the United States, or some other country approved by the electors to the scholarships. The emoluments of the scholar while in England will be about 80*l*. a year, but when travelling abroad a larger sum will be given, which in the case of scholars travelling in the United States will probably be about 250*l*. per annum. The scholars are to furnish reports of their investigations in the foreign countries which they visit. These scholarships are intended by Mr. Gartside to be an incentive and assistance to those who contemplate a careful study of commercial and industrial methods, and should enable useful information to be obtained with regard to these subjects, both in America and on the Continent.

AT the annual general meeting of the members of University College, London, held last week, Lord Reay moved the following resolution on behalf of the council:—"That this meeting has heard with great satisfaction of the generous offer of the Drapers' Company to make themselves responsible for the debt upon the college to the extent of 30,000*l*., and of another friend

of the college to give an equal sum, conditionally upon the college being incorporated in the University of London, and concurs in the resolution of the council to enter into negotiation with the University with a view to the incorporation." He said the idea of incorporation was not a new one, because when the statutory commissioners were sitting for the purpose of framing the statutes for the reconstitution of the University of London, the council represented to them the intention of the founders and benefactors of University College would only be carried out by incorporation. The commissioners, however, felt that the terms of the Act did not make it possible for them to give effect to the proposal. The council had not abandoned the policy, and since the beginning of the present year events had taken place that brought it within the range of speedy realisation. With regard to the appeal for funds, it was quite obvious that if the work which was being carried out was to be continued, the funds would need a much larger increase. Lord Monkswell, who seconded the resolution, hoped there would be many rich men who would follow the example of their anonymous benefactor. He trusted that the negotiations which they were having with the University of London would be successful, and said that no conciliatory efforts on their part would be wanting. The resolution was adopted.

THE address delivered before the Association of Technical Institutions on January 31, by the president, Lord Avebury, is published in the official report of the proceedings of the meeting. The address was, in a large part, a plea for more liberal recognition of science and modern languages in the time-tables of our schools, supported by the opinions of commissions and other competent authorities. Classics has at present too large a portion of the available time, and science is only tolerated. "An education which excludes science is a one-sided education, and the most learned classical scholar, if he knows nothing of science, is but a half-educated person after all." But the question is not so much one of culture as of equipment for national progress. When, as Lord Avebury remarks, we find commission after commission (composed of men selected for their wisdom and experience), after careful and patient inquiry, one after the other, and with remarkable unanimity, pointing to the neglect of science and of modern languages in our educational system as a grave evil, it must surely be worth while to inquire whether these warnings have been taken to heart, or the recommendations have been carried into effect. Lord Avebury gives instances, most of which are known to readers of NATURE, of industrial progress in Germany due to technical training. "It is evident then," he concludes, "that the technical instruction of Germany has been a very remunerative investment; in the first instance, no doubt, a great national advantage, but a boon also to the world as a whole. These figures bring home to us clearly the importance of the subject. It is obvious how keen competition is going to be. If we are to hold our own, we must supplement the rule of thumb in our workshops—very important in itself—by the rule of brain. Emerson once said that this country 'is prosperous because steam is half an Englishman.' We all hope that Britannia may long rule the waves, but it is most important that she should rule the steam engine and the dynamo as well."

SCIENTIFIC SERIAL.

American Journal of Mathematics, vol. xxiv. No. 1, January.—Cyclic subgroups of the simple ternary linear fractional group in a Galois field, by L. E. Dickson. This paper is an addition to the author's previous one in vol. xxii. pp. 231-252. It gives proofs of results therein stated and adds some new theorems allied to them. The question discussed concerns the substitutions

$$x^1 = \alpha^r x,\ y^1 = \alpha^s y,\ z^1 = \alpha^{-r-s} z,$$

where α is a primitive root of the Galois field of order p^n. Two cases arise according to the value of the greatest common divisor d of 3 and $p^n - 1$.—Curves of triple curvature, by J. G. Hardy. The object of the paper is to add to the results which have been obtained concerning curves L of triple curvature. Equations of motion for systems in a four-dimensional space have been deduced and used to introduce the notion of an instantaneous plane of rotation. The derivation is not new, but it is retained for the sake of clearness. By constructing the principal tetrahedroid at a point of a curve of triple curvature and studying its motion by means of the kinematical equations obtained, geometrical interpretations of the six rotations and also a set of formulæ corresponding to the Serret-Frenet formulæ for curves of double curvature have been arrived at. These formulæ have been applied to the study of curves L and, in particular, of the osculating hypersphere and the locus of its centres. Many of the results were contained in a paper read before the mathematical seminary of the Johns Hopkins University in 1898, and so were antecedent to the articles by Prof. Lovett and Mr. Hatzidakis in vol. xxii. The subject may be studied in Brunel, *Math. Ann.* xix. p. 48; Pirondini, *Giom. di Mat.* xxviii. p. 237; and Piccioli, *Giom. di Mat.* xxxvi. p. 273.—Primary prime functions in several variables, and a generalisation of an important theorem of Dedekind, by H. Hancock. Reference is made to Kronecker, "Grundzüge," &c., § 4, p. 11; Runge, *Crelle*, Bd. xcix. p. 89; Mandl, *Crelle*, cxiii. p. 252; Meyer, *Math. Ann.* Bd. xxx. p. 30, and to other memoirs.—On certain properties of the plane cubic curve in relation to the circular points at infinity, by R. A. Roberts. In this second part, which is on certain plane cubic curves and their angles of intersection, with some account of conics cutting orthogonally, the author investigates some methods of generating certain plane cubic curves in such a way that their angles of intersection assume a simple form.—Estimate of Peirce's linear associative algebra, by H. E. Hawkes. In the fourth volume of the *Journal* there appeared a memoir by Peirce in which he attempted to classify and enumerate hyper-complex number-systems. This does not seem to have received on the Continent the credit it deserves. In order that it should receive due recognition, Mr. Hawkes claims that three questions must be discussed, viz., what problem did Peirce attack, and to what extent did he solve it? what relation does this problem bear to that treated by Study and Scheffers? and to what extent do Peirce's methods assist in the solution of that problem? In the present article, Mr. Hawkes discusses the first two questions, and discusses the last in the *Transactions* of the American Mathematical Society, vol. iii. A historical review accompanies the article. It may be remembered that Mr. Spottiswoode drew attention to Peirce's work in his presidential address before the London Mathematical Society (vol. iv. p. 152); see also Cayley, "Collected Works," xi. p. 465; xii. p. 465.—Dr. G. A. Miller furnishes a short note on groups defined by the orders of two generators and the order of their product.—A fine portrait of Prof. Benjamin Peirce is given with the number.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, December 12, 1901.—"The Effective Temperature of the Sun." By W. E. Wilson, D.Sc., F.R.S.

In a memoir by the author and Mr. P. L. Gray, entitled "Experimental Investigations on the Effective Temperature of the Sun," published in the *Phil. Trans.* Roy. Soc. A. vol. clxxxv. (1894), the method described was as follows:—A beam of sunlight reflected from a Stoney single-mirror heliostat was directed into one aperture of a Boys' differential radio-micrometer. The other aperture received the radiation from a small circular area of a strip of platinum raised to any desired temperature by an electric current, this temperature being measured by the linear expansion of the platinum as in Joly's meldometer. Knowing then the ratio of angular diameter of radiating area of platinum to that of sun, the temperature of the platinum strip, the emissivity of bright platinum and the amount of the sun's radiation lost by absorption in the earth's atmosphere and by reflection from the heliostat mirror, it is possible in any assumption of a law connecting radiation with temperature to determine the effective solar temperature. The mean of a series of very accordant observations gave 6200° C. (absolute).

To protect the incandescent strip from draughts of air it was covered with a water-jacket of gilded brass. Possibly some of the radiation from distant parts of the strip may have been reflected between the polished walls and the strip itself and, ultimately escaping through the circular aperture fronting the radio-micrometer, reached it and so vitiated the result. Smoking the interior of the water-jacket sensibly reduced the amount of radiation and so proved this surmise correct.

It is also possible that changes in the surface condition of the platinum may effect its emissivity, which in the original memoir was taken at 0·35 that of lamp-black (Rosetti's estimate), so that it is a distinct advantage to abolish the platinum strip as a source of radiation and to substitute a uniformly heated enclosure which would radiate as an absolutely black body.

In 1895 Mr. Lanchester pointed out to the author that such an enclosure would be a theoretically perfect radiator; while Lummer, Paschen and others using radiation from such a source have confirmed in a remarkable manner Stefan's law of radiation, viz. $R = aT^4$.

The radiator employed was a porcelain[1] tube 2 feet long and 1 inch internal diameter fitted into a Fletcher gas-tube furnace. A plug of asbestos was inserted in the tube about 10 inches from the end remote from the radio-micrometer, and resting against this plug was the end of a Callendar platinum resistance thermometer. In front of the open end of the tube was a rectangular aperture 5 mm. wide in a large brass water-screen; a slide closing this aperture was moved by a micrometer screw reading to 0·01 mm. This aperture was 66·3 mm. from the surface of the thermocouple (Fig. 1).

To make an observation, the tube was heated to as high a temperature as the furnace was capable of, and the radiation from the interior of the tube passing into the aperture (B) of the radio-micrometer was adjusted by the micrometer screw until a balance was obtained with the radiation of the sun through the aperture (A).

After a series of observations had been made, the arrangement was altered so that the radiation from the tube should enter aperture (A) and from the sun aperture (B) of the radio-micrometer, and in this position a second series of observations was taken. The geometric mean of the results of the two groups gives the effective temperature of the sun.

The mean of the observations thus made gave 5773° C. (absolute) as the sun's effective temperature.

In calculating this result, Rosetti's coefficient of atmospheric absorption, viz. 0·29, has been used. Taking Langley's value, viz. 0·41, the result will be 6085° C. (absolute).

It is interesting to allow for the effect of absorption in the sun's atmosphere. Assuming the results of Wilson and Rambaut's experiments (*Proceedings* Royal Irish Academy, 1892, vol. ii. No. 2), the value 6863° C. (absolute) is deduced as the effective temperature of the sun's photosphere.

Physical Society, February 28.—Prof. S. P. Thompson, president, in the chair.—A paper on focal lines and anchor-ring wave-fronts was read by Prof. J. D. Everett. When a small cone of rays is obliquely incident on a spherical reflecting or refracting surface, the rays after reflection or refraction no longer compose a true cone. Instead of meeting in a point they form a narrow neck, and this neck is flattened in two places called the *two focal points*, the planes of flattening being at right angles to each other. Optical writers give the name *focal lines* to the sections of the pencil made at the focal points by planes perpendicular to the axis of the pencil; but it would be more appropriate to give the name to the sections which most nearly resemble lines, whatever angle they make with the axis of the pencil. Attention is drawn in the present paper to the case in which the wave-front in one of its positions is a tore (or anchor-ring). Even when dealing with wide-angled pencils there are then two well-defined focal lines, the primary focal line being what may be called the circular axis of the tore, and the secondary a portion of the line about which the generating circle turns to form the anchor-ring. Toric wave-fronts can be produced by reflection from a mirror made by allowing an ellipse or portion of an ellipse to revolve completely round an ordinate erected at one focus, and employing it to reflect rays diverging from a small source at the other focus. The primary line is always real; the secondary is real or virtual according to the position of the area of incidence of the pencil.—A paper entitled "Contributions to the Theory of the Resolving Power of Objectives" was read by Prof. Everett. The practical limit to the resolving power of objectives depends upon the blurring due to diffraction. Observations on double stars for the purpose of investigating the separating power of telescopes have been made by Dawes, who arrived at the conclusion that the angular distance between the two components, when they are nearly equal in magnitude and are just separated, is given by the formula, 4·56 seconds divided by the diameter of the objective in inches. Foucault also investigated the matter experimentally, and in 1830 Airy calculated the brightness at various points of the spot and rings which constitute the image of a point source formed by an objective. If the extreme difference of optical path for disturbances coming from different points of a concave wave-front to a point at lateral distance b from the geometric focus is made equal to the wave-length of light, a value for b is obtained which represents with fair accuracy the limit of separation as determined by experiment. The formula agrees with that of Dawes if λ = ·56 micron., whereas the wave-length of the brightest ray is usually taken as ·55 micron. In the case of microscopes the author has supposed that the formula for the minimum distance b still holds good, and combining this equation with the sine condition applicable to optical systems giving sharp flat images, he has deduced the expression which has been extensively used

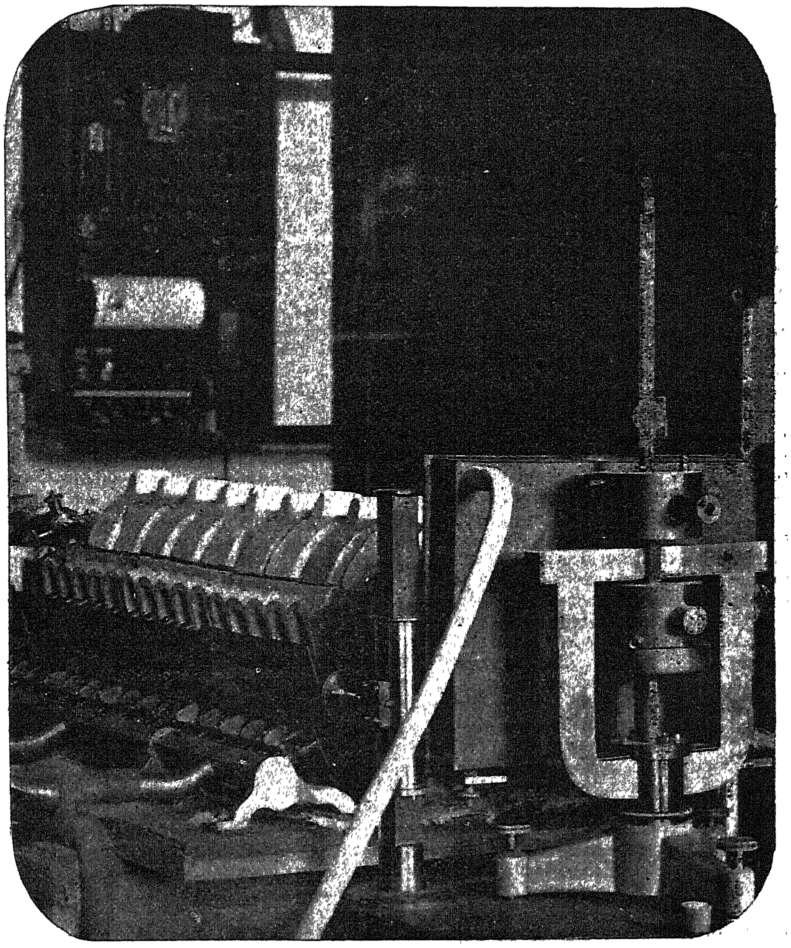

FIG. 1.—Differential radio-micrometer with tube furnace.

[1] In later experiments an iron tube was substituted.

for the distance between lines or points which can be barely separated. Microscopic test objects are not self-luminous, like double stars, but are viewed by transmitted light. If no condensing arrangement is employed, the pencil of light sent by a point of the object to the objective consists, in effect, of rays from different sources. The result of this is that the image of the point is larger and more blurred. The cure for this evil is furnished by employing a condenser of high quality, to throw upon the part of the object under examination a very sharp image of the source of illumination. Each point of the object thus gets its light from its own special point of the source; the object, therefore, acts as if it were self-luminous, and the power of the instrument is increased. The benefit derived from sharp focussing on the object explains the advantage of using an achromatic condenser and not, as formerly recommended by Abbe, one which is not achromatic. Another advantage of sharp focussing by the condenser is that there can be no interference of the light from different parts of the object. The author then gives an explanation of the advantage of oblique illumination, and arrives at the view of microscopists that the obliquity of illumination should be rather less than the obliquity of the extreme rays of the incident pencil. The paper concludes with Hockin's proof of the sine condition.—A paper on the absorption, dispersion and surface colour of selenium, by Prof. R. W. Wood, was read by the secretary. The dispersion of selenium has been investigated by means of prisms made in the same manner as the cyanine prisms already described by the author. The substance is much more transparent than cyanine, and prism angles of four or five degrees can be employed. Determinations were made with three selected prisms down to wave-length 61; below this the interferometer method was employed. Uniform films of selenium were obtained on plates of plane parallel glass by means of a flat selenium kathode in a high vacuum, and the displacements of the interference fringes by the introduction of the films were measured for lights of different known wave-lengths. Wedge-shaped films were then employed, which allowed the displacement for any wave-length to be measured for the maximum thickness capable of transmitting the light. An advantage of the wedge-shaped films is that the fringes are curved and the displaced fringe can be easily identified with the undisplaced. The refractive indices obtained in the red by prisms were used as a basis for the calculation of the indices in the rest of the spectrum from the interferometer measurements. Determinations were made in this way down to wave-length 40, beyond which it was impossible to go owing to the powerful absorption. A curve has been plotted showing the relation between refractive index and wave-length. It has a maximum at wave-length 50 (·00005 cm.), where the refractive index is 3·13. An examination of the light transmitted by a thin film showed that there was no return of transparency in the ultra-violet at least down to wave-length 28. Photometric measurements were made of the transmitted light, both visible and ultra-violet, and a curve has been drawn with wave-lengths as abscissæ and extinction coefficients as ordinates. It is proved that the extinction coefficient increases continuously with decrease in wave-length as far as wave-length 22, where the coefficient has as high a value as in the case of metals. The author concludes that the absorption is due, not to a single band, but to a series of overlapping bands. The object of this work was to determine whether there was a return to partial transparency in the ultra-violet region. This question appears to be answered in the negative, although a possible turning-point in the curve might be masked by the reflection coefficient of selenium. The high value of the extinction coefficient in the ultra-violet led the author to look for traces of selective reflection in this region. The light of an arc lamp was reflected successively from six surfaces of selenium, and the image of the crater after the sixth reflection, although faint, was without colour or excess of ultra-violet light. If the data obtained in the paper for refractive index and extinction are used in the formula for reflection from an absorbing medium, a result is arrived at which indicates that the reflection increases rapidly with decreasing wave-length. As multiple reflections from selenium surfaces give no trace of colour, errors must exist in either the refraction or the extinction curve. The author suggests that in the case of films of thickness less than the wave-length of light, the displacement of the interference fringes does not give a measure of the refractive index.—The chairman exhibited some tellurium mirrors made in the same way as the selenium ones used by Prof. Wood.

Chemical Society, February 19.—Prof. Emerson Reynolds, V.P.R.S., president, in the chair.—The union of hydrogen and oxygen, by Mr. H. B. Baker. The author has devoted, during the last few years, much attention to the inhibition of chemical action produced by thoroughly drying substances, but until quite recently had not succeeded in so completely desiccating a mixture of oxygen and hydrogen as to prevent the explosion of such a mixture when electric sparks were passed through it. He has now found that by electrolysing a solution of barium hydroxide it is possible to obtain a mixture of these gases which, when dried over phosphorus pentoxide, is no longer exploded by electric sparks or by the application of intense heat, the highly explosive character of the mixture, however, being regained by the introduction of a mere trace of moisture.—Enzyme action, by Prof. A. J. Brown. Some years ago the author showed that the fermentation of saccharine solutions by yeast does not proceed according to the ordinary mass law which governs chemical reactions. On the other hand, O'Sullivan and Tompson found that the inversion of cane sugar by the enzyme invertase follows this law. Since both of these reactions, in the light of Buchner's researches on zymase, are produced by enzymes, there appeared to be a remarkable difference in the operation of the latter. The inversion of sucrose by invertase has, therefore, been reinvestigated by the author, who finds that this reaction does not progress according to the mass law, but in precisely the same way as the fermentation of sugars by yeast. The explanation of this feature of enzyme action is, the author thinks, the formation of an intermediate unstable compound between the enzyme and the substance it is decomposing, thus introducing a time factor which obscures the mass influence.—On the velocity of hydrolysis of starch by diastase, with some remarks on enzyme action, by Mr. H. T. Brown, F.R.S., and Mr. T. A. Glendinning. The authors confirm the results obtained by Prof. Adrian Brown with regard to the progression of hydrolytic reactions caused by enzymes, but they explain the peculiarity exhibited in a different manner, an attempt being made to connect enzyme hydrolysis with acid hydrolysis, the unstable combination of starch or sugar with the enzyme being regarded as the hydrolyte and the active dissociated water molecules present as the hydrolysts.—Polymerisation products from diazoacetic ester, by Dr. O. Silberrad. Three series of polymerides are obtainable from diazoacetic ester, and the present paper gives an account of the results of experiments on the so-called "pseudo-diazoacetamide," whereby the author has been able to assign a constitution to this substance.—Condensation of phenols with esters of unsaturated acids, by Dr. S. Ruhemann. The author describes the products obtained by the action of ethyl chlorofumarate on guaiacol and α-naphthol, whereby a benzopyrone and a naphtharone are respectively formed.—The chemical change produced by the immersion of lead in distilled water, by Dr. F. Clowes. Distilled water, recently boiled, exerts very little action upon metallic lead immersed in it, but unboiled distilled water converts the metal into hydroxide of lead, which remains in solution, and into a hydrated carbonate, which is precipitated. The principal agent in effecting this change appears to be the oxygen dissolved in the water.—The bases contained in Scottish shale oil, part i., by Messrs. F. C. Garrett and J. A. Smythe. The fraction of Broxburn shale oil boiling below 164° contains pyridine and several of its homologues.—Note on liquid nitrogen peroxide as a solvent, by Prof. P. F. Frankland, F.R.S., and Dr. R. C. Farmer. The authors note that in their recent paper on this subject they inadvertently omitted any reference to the previous work by Bruni and Berti, who investigated the cryoscopy of nitrogen peroxide solutions of various substances and pointed out the associating power of this solvent.

Linnean Society, February 6.—Prof. S. H. Vines, F.R.S., president, in the chair.—Prof. Reynolds Green, F.R.S., exhibited some primroses which showed the rare phenomenon of sepalody. The corolla was green and the limbs of the petals were rugose and of a texture almost comparable with that of the foliage-leaves. He also showed another specimen in which the calyx as well as the corolla was petaloid. Both specimens were received from a garden in the north of England.—Messrs. H. and J. Groves exhibited a series of British hybrid batrachian Ranunculi, together with specimens of their supposed parents. They pointed out that the hybrids were usually characterised by (1) being intermediate in appearance between the two parents, having some of the distinctive characters of each, but with a

more vigorous vegetative growth, and (2) by the fruit being mostly abortive and the peduncles not becoming recurved.—Mr. Francis Darwin, F.R.S., read a paper on a method of investigating the gravitational sensitiveness of the root-tip, showing the apparatus used and lantern-slides of seedlings under experiment. Confining himself to the modern development of the question, the author remarked that the observations of Czapek and of Pfeffer having been contradicted by Wachtel, it had become desirable to confirm these observations by employing a different method. The apparatus used consisted of a counter-balanced lever 53 cm. long, able to turn in any direction by being mounted on knife-edges. Seedlings of the bean and the pea were employed, and glass tubes, straws and dandelion scape were in turn used to contain the root-tip, and, by the aid of certain mechanical appliances, to prevent the root slipping out of the tube. The tip being fixed, the remaining part of the root and the hypocotyl became curved in varying degrees, due to the continued stimulation of the root-tip. The result has been confirmation of the observations made both by Czapek and by Pfeffer.—Dr. D. H. Scott, F.R.S., gave an account (illustrated by lantern-slides) of an extinct family of ferns—the Botryopterideæ, our knowledge of which is primarily due to the researches of M. Renault.

Zoological Society, February 18.—Prof. G. B. Howes, F.R.S., vice-president, in the chair.—Mr. W. B. Tegetmeier exhibited and made remarks upon the skull of a supposed hybrid between the sheep and the pig, named "cuino" by the inhabitants of Mexico, where it is stated to be extensively reared as an agricultural animal. The skull was clearly that of a pig. —Dr. C. I. Forsyth Major exhibited and made remarks upon some remains of voles from the Upper Val d'Arno (Italy) and from the Norwich Crag, representing *Microtus pliocaenicus* (Maj.) and *Microtus intermedius* (Newt.). Dr. Forsyth Major considered that they belonged to a distinct genus, which he proposed to name Mimomys.—Mr. R. Lydekker exhibited, on behalf of Mr. Rowland Ward, two pairs of antlers and a skull of an elk from Siberia (beyond the Altai). Mr. Lydekker pointed out that, although belonging to adult animals (as the dentition of the skull indicated), the antlers had practically no palmation—a characteristic which induced him to propose the specific name *Alces bedfordiae* for the Siberian elk.—Dr. C. I. Forsyth Major gave a description of *Mustela palaeattica*, Weith., from the Upper Miocene of Pikermi and Samos, based chiefly on an almost perfect skull from Pikermi in the Turin Museum. —Mr. Oldfield Thomas, F.R.S., read a description of two new rodents discovered by Mr. P. O. Simons near Potosi, Bolivia. The one proposed to be called *Neoctodon simonsi* was allied to Octodon, but had simpler teeth, without enamel infoldings, and a bushy tail, the size and external appearance being much those of *Neotoma cinerea*. The second, called *Andinomys edax*, was allied to Phyllotis, but had much larger, more complicated and highly hypsodont teeth; in general appearance it was like a large Phyllotis, such as *Ph. darwini*. Its head and body measured 160 mm. and its tail 145 mm.—Mr. Oldfield Thomas also read a paper on some new mammals from northern Nyasaland, which had been contributed to the National Museum by Commissioner Alfred Sharpe, C.B., and Colonel Manning. —Mr. Boulenger, F.R.S., made remarks on the characters of the very young form of Polypterus, connecting the early stage recently discovered by Mr. Budgett with the more advanced stages described by Dr. Steindachner and himself. Characters were pointed out by which the young of *Polypteri lapradii*, *congicus*, *endlicheri*, *weeksii*, *senegalus* and *palmas* could be distinguished. Special attention was drawn to young specimens of *P. lapradii* from Nigeria, in which the external gills measured up to one-third of the total length.—Mr. Boulenger also drew attention to a new snake of the genus Psammophis, from Cape Colony, of which a specimen had been presented to the British Museum by Dr. G. Leighton. The name *P. leightoni* was proposed for this new species.—Mr. F. E. Beddard, F.R.S., read a paper dealing with the tuft of vibrissæ commonly met with upon the wrist of mammals belonging to the orders Lemuroidea, Carnivora, Rodentia and Marsupialia. It was pointed out that this structure was found in both sexes and in a large proportion of the genera and species belonging to the mammalian groups mentioned. As to other orders of mammals, the only ungulate in which they had been discovered was stated to be Hyrax; of edentates, the armadillos alone possessed these vibrissæ upon the wrist.

CAMBRIDGE.

Philosophical Society, February 17.—Prof. Macalister, president, in the chair.—The histology of the endosperm during germination in *Tamus communis* and *Galium tricorne*, by Mr. Walter Gardiner, F.R.S., and Mr. Arthur W. Hill. After briefly describing the stages in the germination of *Tamus communis*, the authors gave an account of the histology of the endosperm and of the changes which accompany the dissolution of the cell walls.—Demonstration on the dimorphism of the Foraminifera, by Mr. J. J. Lister.—On the differentiation and integration of divergent series, by Mr. G. H. Hardy. The paper contains some discussion of the general principles in accordance with which we may attribute conventional values to analytical expressions which do not represent any determinate quantity when interpreted in the ordinary way. In particular it is shown how they lead to Borel's definition of the sum of a divergent series. It also contains investigations as to the possibility of applying the ordinary operations of the calculus to divergent series whose sums are defined as by Borel. A series of general theorems is proved, and applications are made to the evaluation of definite integrals and the theory of trigonometrical series.

PARIS.

Academy of Sciences, February 24.—M. Bouquet de la Grye in the chair.—On transcendental meromorphs defined by differential equations of the second order, by M. Paul Painlevé.—On the origin of stolonial formations, by M. Edmond Perrier.—On the impossibility of certain permanent states in viscous liquids, by M. P. Duhem.—M. Baillaud was elected a correspondant for the section of astronomy in the place of the late M. Souillart.—On some transformations of Backland, by M. E. Goursat.—The application of Duddell's singing arc to the measurement of small coefficients of self-induction, by M. Paul Janet. It is known from the experiments of Duddell that there is a simple relation between the period of the note given out by a singing arc, the capacity and the self-induction of the circuit. By measuring the intensity of the current with a thermal ammeter, the difference of potential with a thermal voltmeter, and working with condenser of known capacity, it is shown that coefficients of self-induction smaller than 0·003 Henry can be measured.—On a capillary electrometer, by M. Pierre Boley. The Lippmann capillary electrometer will not work with saturated liquid amalgams which are not sufficiently mobile in the narrow tubes. It has therefore been modified to meet this special case. Its sensibility was found to be of the order of ·00003 volt.—On some properties of azobenzene and hydrazobenzene, by MM. P. Freundler and L. Béranger. The Friedel and Crafts reaction cannot be utilised for the preparation of ketones from azo-bodies.—On the constitution of dibutylic and diœnanthylic alcohols, by M. Marcel Guerbet. By a careful study of the oxidation products of these two alcohols, it was found that they are represented by the formulæ $CH_3.CH(C_4H_9).CH_2.CH_2OH$ and $CH_3.CH_2.CH_2.CH(C_7H_{15}).CH_2.CH_2.OH$.—On the polymerised state of ordinary indigo and the isomeric transformation of indigotin into indirubin, by M. L. Maillard.—On some reactions obtained with the aid of magnesium amalgam, by M. L. Meunier. Magnesium amalgam attacks ethyl alcohol even in the cold, magnesium ethylate being formed. The alkyl iodides are more readily attacked by this reagent than by the copper-zinc couple, the saturated hydrocarbon being formed. Ordinary aldehyde reacts violently with magnesium amalgam, the symmetrical dioxybutane, $CH_3.CHOH.CHOH.CH_3$, being produced.—On the constitution of tariric acid, by M. Arnaud.—A new method for characterising the pseudo-acids, and on its application to the oximidocyanacetic esters, by M. P. Th. Muller. Measurements are made of the molecular refraction and molecular dispersion.—On some derivatives of methyl-nonyl-ketone, by M. H. Carette. By the addition of hydrocyanic acid to this ketone and the subsequent hydrolysis of the nitrile produced, the corresponding amide and acid were obtained, the properties of which are described.—On an important source of error in the examination of diastases, by MM. Emm. Pozzi-Escot. The colour reaction with tincture of guaiacum, which has been relied upon in many researches, is now found to fail in certain cases. From this it follows that a certain number of published works on the diastases and their localisation in particular cells are of no value. —On the analysis of ceramic products, by M. V. de Luynes.

For the analysis of objects in relief on porcelain of a different composition, advantage is taken of the action of a layer of drying glycerine in removing the surface of porcelain or glass.—Search for fatty acids in contaminated waters, by M. H. Causse. The amounts of fatty acids present in a water are regarded by the author as measuring the contamination, and methods are given for separating and estimating the quantities of such acids present.—The resistance of the red globules of the blood determined by its electrical conductivity, by MM. Calugareanu and Victor Henri. In the determination of the resistance of the red globules of the blood, it is necessary to determine both the hæmoglobin and the salts. This determination can be made with great precision by measuring the electric conductivity of the solutions. The application of this method has shown that the red globules may lose a part of their salts without any corresponding change in their colouring-matter.—On the simultaneous production of indoxyl and urea in the organism, by M. Julius Gnezda.—On asphyxia by the gases of drains, by M. Hanriot. Accidental cases of asphyxia in drains are usually attributed in the text-books to the presence of sulphuretted hydrogen. Analyses of the air in ventilated drains showed that this gas was either absent or present in such small proportion as to have no appreciable effect. In unventilated drains the amounts were larger, ·03 to ·05 per cent., but still too small to exert a poisonous action. The air in the unventilated drains was irrespirable on account of the large amount of carbonic acid present and the deficiency in oxygen, and hence no disinfectant that might be proposed would meet the case. The only practicable means of rendering the air of a drain inoffensive is energetic ventilation at the time the workmen are descending.—On the germination of Onguekoa and Strombosia, by M. Edouard Heckel.—On the tectonic of the neighbourhood of Biarritz, Bidart and Villefranque, by M. Leon Bertrand.—On the existence of phenomena of overlapping in the subbetic zone, by M. René Nicklès.—A geological map of Bambouk, in the French Soudan, on the scale of 1/250,000, by M. Alex. J. Bourdariat.—On the constitution of the suboceanic soil, by M. J. Thoulet.

DIARY OF SOCIETIES.

THURSDAY, MARCH 6.

ROYAL SOCIETY, at 4.30.—On the Spark Discharge from Metallic Poles in Water: Sir Norman Lockyer, F.R.S.—Experimental Researches on Drawn Steel. Part I. The Influence of Changes of Temperature on Magnetism. Part II. Resistivity, Elasticity and Density, and the Temperature Coefficients of Resistivity and Elasticity: J. R. Ashworth.—On the Effects of Magnetisation on the Electric Conductivity of Iron and Nickel: G. Barlow.—The Differential Equations of Fresnel's Polarisation-Vector, with an Extension to the Case of Active Media: J. Walker.—On a convenient Terminology for the various Stages of the Malaria Parasite: Prof. E. Ray Lankester, F.R.S.

LINNEAN SOCIETY, at 8.—On some New Species of Lepadidæ in the British Museum (Nat. Hist.): Prof. A. Gruvel.—On the Morphology of the Brain in the Mammalia, with Special Reference to the Lemurs, Recent and Extinct: Dr. G. Elliot Smith.

RÖNTGEN SOCIETY, at 8.30.—Localisation; with Demonstration of a Simple Direct Reading Apparatus: Dr. Barry Blacker.

CHEMICAL SOCIETY, at 8.—The Slow Oxidation of Methane at Low Temperatures: W. A. Bone and R. V. Wheeler.—Isomeric Additive Compounds of Dibenzyl Ketone and Deoxybenzoin with Benzal-*p*-toluidine, *m*-Nitrobenzalaniline and Benzal-*m*-nitraniline, Part III.: F. E. Francis.—Mesoxalic Semi-Aldehyde: H. J. H. Fenton and J. H. Ryffel.—*m*-Nitrobenzoylcamphor: M. O. Forster and F. M. G. Micklethwait.—Picrimidothiocarbonic Esters: J. C. Crocker.

FRIDAY, MARCH 7.

ROYAL INSTITUTION, at 9.—Radio-active Bodies: Prof. H. Becquerel.

GEOLOGISTS' ASSOCIATION, at 8.—The Zones of the White Chalk of the English Coast. III. Devonshire: Dr. A. W. Rowe.

SATURDAY, MARCH 8.

ROYAL INSTITUTION, at 3.—Some Electrical Developments: Lord Rayleigh, F.R.S.

ESSEX FIELD CLUB (at Essex Museum of Natural History, Stratford), at 6.30.—The Spiders of Epping Forest: Frank P. Smith.—Eolithic Implements from the Plateau Grave around Walderslade: J. P. Johnson.

MONDAY, MARCH 10.

SOCIETY OF CHEMICAL INDUSTRY, at 8.—Birmingham Sewage and its Treatment: F. R. O'Shaughnessy.—Remarks on the Technical Examination of Glue: E. G. Clayton.

ROYAL GEOGRAPHICAL SOCIETY, at 8.30.—The Geographical Conditions determining History and Religion in Asia Minor: Prof. W. M. Ramsay.

SOCIETY OF ARTS, at 8.—Photography applied to Illustration and Printing: J. D. Geddes.

TUESDAY, MARCH 11.

ROYAL INSTITUTION, at 3.—Recent Researches on Protective Resemblance, Warning Colours and Mimicry in Insects: Prof. E. B. Poulton, F.R.S.

INSTITUTION OF CIVIL ENGINEERS, at 8.—*Paper to be further discussed*: —Electrical Traction on Railways: W. M. Mordey and B. M. Jenkin.

AERONAUTICAL SOCIETY (Society of Arts), at 8.—The Development of Aërial Navigation in Germany: Major W. L. Moedebeck.—Balloon Photography: Miss Gertrude Bacon.—The Barton Airship: Dr. F. A. Barton.

ANTHROPOLOGICAL INSTITUTE, at 8.30.—A Collection of Andamanese Objects, presented to the Museum, Royal Gardens, Kew, by P. Vaux, Esq.: Exhibited by Sir William Thiselton-Dyer, K.C.M.G., F.R.S.—The Nicobar Islanders: Extracts from Diaries kept in Car Nicobar by V. Solomons, Esq., 1895-1900: Communicated by Col. R. C. Temple, C.I.E.

WEDNESDAY, MARCH 12.

SOCIETY OF ARTS, at 8.—The Utility of Alkaline Phosphatic Manures: J. Hughes.

GEOLOGICAL SOCIETY, at 8.—The Crystalline Limestones of Ceylon: A. K. Coomára-Swámy.—Researches among some of the Proterozoic Gasteropoda which have been referred to Murchisonia and Pleurotomaria, with Descriptions of New Species: Miss Jane Donald.

THURSDAY, MARCH 13.

ROYAL SOCIETY, at 4.30.—Croonian Lecture on the Physico-Chemical Properties of Hæmoglobin, its Compounds and Derivatives: Prof. A. Gamgee, F.R.S.

INSTITUTION OF ELECTRICAL ENGINEERS, at 8.—Adjourned discussion on the following papers:—Electric Shock and Legislation thereon: Major-General C. E. Webber, C.B., R.E.—Electric Shocks: F. B. Aspinall.—Electric Shocks at 500 volts: A. P. Trotter.

MATHEMATICAL SOCIETY, at 5.30.—The Theory of Cauchy's Principal values (III.): Mr. G. H. Hardy.—The Solutions of a System of Linear Congruences: Rev. J. Cullen.

SOCIETY OF ARTS (Indian Section), at 4.30.—The Indian Famine of 1899, and the Measures taken to meet It: T. W. Holderness.

FRIDAY, MARCH 14.

ROYAL INSTITUTION, at 9.—Magnetism in Transitu: Prof. S. P. Thompson, F.R.S.

ROYAL ASTRONOMICAL SOCIETY, at 8.

MALACOLOGICAL SOCIETY, at 8.

INSTITUTION OF CIVIL ENGINEERS, at 8.—The Use of Long Steel Wires in Surveying: H. J. Deane.

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THURSDAY, MARCH 13, 1902.

A NEW MANUAL OF THE PROTOZOA.

The Protozoa. By Gary N. Calkins. Columbia University Biological Series, VI. Pp. xvi + 347; 153 text-figures. (New York: The Macmillan Co. London: Macmillan and Co., Ltd., 1901.) Price 12*s.* 6*d.* net.

BIOLOGISTS have understood for a long time past the importance of the study of the Protozoa as an indispensable aid to the solution of some of the most fundamental problems of biology. Of recent years, however, a lively interest in this class of organisms has been awakened in many others besides those whose field of investigation includes the Protozoa amongst its recognised subjects. Medical researchers, for instance, require now to know more about the simplest forms of animal life than they were taught, as students, in their elementary courses of biology, and even the general public has had its attention directed to "microbes" by the recent discoveries concerning the etiology of malaria and the wonderful life-history of its minute parasite. The time is opportune, therefore, for the publication of a general account of the Protozoa, and the latest addition to the well-known Columbia Series is a handy volume which will be welcomed by many classes of readers. The author has not aimed at putting forward an exhaustive, severely scientific treatise upon the group in question. His work may be described rather as a simple and intelligible introduction to the study of the Protozoa and of the many fascinating biological problems connected with, or illustrated by, this subdivision of the animal kingdom, in such a way as to awaken the interest of the beginner, no less than to strengthen the hands of the expert. The book is written in plain language, with avoidance of unnecessary technicalities, and is profusely illustrated by a great number of very excellent figures, in the preparation of which the author acknowledges the assistance of his wife, whose skilful draughtsmanship cannot be praised too highly.

The author treats his subject, as stated in the preface, from three points of view: (1) the historical, which occupies the first chapter; (2) the comparative, on which five chapters are spent; and (3) the general, to which the last three chapters are devoted. The historical and introductory chapter gives an extremely interesting account of the progress of our knowledge of the Protozoa, and traces the gradual elimination of the many erroneous notions prevalent even not so very long ago.

The comparative account is a useful review of the whole group and of the four principal subdivisions, the Sarcodina, Mastigophora, Sporozoa and Infusoria. The author is extremely up to date in his facts, and makes use of the most recent observations and discoveries. In the chapter on Sporozoa we find Siedlecki's recent account of the conjugation of the sporoblasts in *Monocystis* (*Lankesteria*) *ascidiae* taken as typical for the class (p. 151) and made the basis of six good diagrammatic figures representing the "scheme of sporulation in gregarinida" (Fig. 84, p. 152). The book must have been out of the author's hands before the publication of Cuénot's recent memoir describing a perfectly similar type of conjugation in the common Monocystis of the earthworm, but it is nevertheless unfortunate that the now exploded account put forward by Wolters for this type should be quoted so frequently (pp. 157, 235 and elsewhere), especially as Wolters' statements are directly at variance with the "scheme of sporulation" to which reference has been made.

The three general chapters deal with sexual phenomena in the Protozoa, with the special morphology of the Protozoan nucleus, and with some problems in the physiology of the Protozoa respectively. The sexual phenomena are divided into four categories—union of similar adult individuals, of similar but different-sized individuals, of swarm spores or reduced individuals, and, lastly, of "eggs and spermatozoa," *i.e.* of highly differentiated gametes. A great deal of very interesting matter is brought forward under each heading, but the facts relating to the Coccidia, which form the bulk of the fourth subdivision, are set down in a very inaccurate manner, and require revision. It is not true, for instance, to say that "so far as the nucleus (of the macro gamete) is concerned, . . . no maturation process has been recorded," unless the term maturation be used in a very restricted sense. In *Adelea ovata* the entrance of a male element is not effected through a special opening or micropyle, as stated; but perhaps *Coccidium proprium* is meant, where this does occur. Again, it is incorrect to say that in *Adelea ovata* the microgamete divides twice while in contact with the macrogamete, and that three of the resulting nuclei are eliminated. It is the microgametocyte which divides in this way to furnish four microgametes, one of which fertilises the "egg." In a book which bears evidence of so much careful and well-considered work, it is strange to find so many misstatements so close together, but the whole paragraph (pp. 229-232), from which is taken the above statement concerning the microgamete, is confused and contradictory, since, beginning by referring to Adelea by name, and without introducing the name of any other species, it goes on to make statements which evidently refer to Coccidium, and then to institute comparisons between the facts stated and the processes occurring in other Coccidia, including Adelea itself.

In the chapter dealing with the nucleus, an attempt is made to trace the steps in the elaboration of the structure of Protozoan nuclei and of the mechanism of nuclear division. Four stages are recognised in the evolution of nuclear structure: (1) compact spheres of chromatin, multiple division of which is the prelude to the reproduction of the cell; (2) nuclei with membranes, enclosing each one or more chromatin masses or "karyosomes," which break up to form granules, and the granules unite secondarily in lines forming primitive chromosomes; (3) nuclei without karyosomes, with granules distributed widely over the nuclear framework; (4) nuclei with granules as in (3), or aggregated into "net knots" which break up into granules at the period of nuclear division, the granules then coming together in lines which segment into chromosomes of definite number and size. The fourth and highest of these stages is that found in Metazoa and Metaphyta. The author comes to the conclusion

that "the centre of activity in the division of the Protozoan cell, as in the Metazoa, resides in a special structure," which he terms the division centre, regarding it as "a specific substance different from the chromatin and from the cytoplasm." The origin of the division centre is doubtful, but "the widespread intranuclear condition favours the view that it originated there." It is not possible to deal here with the wealth of interesting facts which are marshalled in support of these conclusions, but it is strange that although Schaudinn's now well-known figure illustrating the life cycle of Coccidium is given twice over, no mention is made of his striking observations upon the origin of karyosome, and the *rôle* played by it in nuclear division, in the "endogenous" cycle of this type, nor is Schaudinn's memoir (1900) cited in the bibliography, which contains few references later than 1899.

In the chapters upon physiology, the facts and conclusions are arranged under the headings Intracellular Digestion, Respiration, Secretion and Excretion, Irritability and, finally, General Considerations.

In a work of this size there is, of course, much to criticise, and we may draw attention to a few errors or omissions, such as will always creep into the best regulated manuscripts. Spermatozoa are said, on p. 8, to have been withdrawn from the Protozoa during the present century! The Coccidian genus Minchinia is termed Myxinia on p. 20 (description of Fig. 6). In Fig. 31 B (p. 63) is depicted an associating couple or "syzygy" of polycystid gregarines, which look not unlike the common *Clepsydrina ovata* from the meal-worm; but the figure is labelled *Monocystis agilis*, Leuck. (*sic*). For Fig. 77, illustrating the development of a gregarine, Wasielewski is given as the authority, instead of the veteran investigator of the Sporozoa, Aimé Schneider. When the author states, on p. 146, that the Sporozoa are mononucleate (*sic*), "with the exception of the multinucleate Myxosporidiida," he should have added "and Sarcosporidiida," since a uninucleate Sarcosporidian has not yet been seen, leaving out of account the spores and reproductive bodies.

These are all trifles, but there is one feature of the book to which we wish to take exception; that is the author's practice of altering the form of well-known and familiar names of classes and orders. A similar tampering with names universally accepted and employed, in the vain effort to strive after uniformity—vain because in many cases it is very doubtful whether a given group of animals should be considered as a subclass, order or suborder—was a blemish upon the encyclopædic treatment of the Protozoa by Delage and Hérouard in the "Zoologie Concrète," where we find such monstrosities as "Ciliæ" and "Flagellia" for what everyone terms Ciliata and Flagellata. The desire of the author under review is to make all the subclasses end in "idia," the orders in "ida," and he adds this termination even to groups which in common usage already have it, *e.g.* "Myxosporidiida," "Hæmosporidiida." But the author has not the courage of his convictions to the same extent as Delage, for while writing "Flagellidia" he shrinks from "Ciliidia" or "Suctoriidia," retaining the usual appellations Ciliata and Suctoria. Endeavours to alter names in this way, however desirable, are absolutely useless unless proposed by some international convention, sufficiently representative and authoritative for all to be agreed to follow its ruling. When attempted by individuals it only leads to confusion. Are we to speak o "Flagellia" with Delage, or of "Flagellidia" with Calkins? The majority of us will continue to say and to write "Flagellata" to the end of our days. While on the subject of terminology and nomenclature, it may be noted that the author actually names two new species; one in the description of Fig. 13, on p. 41, and another in that of Fig. 134, p. 251. The professed systematist and bibliographer must surely consider this a most reprehensible act in a work of this kind.

The work is provided with short special bibliographies at the end of each chapter, as well as with a general bibliography at the end of the book. The excellence of the figures has been pointed out, but it should be further noted that many of them are original, and of the latter we would draw special attention to the figure of division in Gonium (p. 129), to that illustrating a phase in the conjugation in Arcella (p. 218), and to the figure of mitosis in *Tetramitus chilomonas* [n. sp.] (p. 270). In conclusion, we heartily congratulate the editors of the Columbia University Biological Series on their latest volume, which keeps up the high standard of excellence of its predecessors.

E. A. M.

GREEK TOPOGRAPHY IN RELATION TO HISTORY.

The Great Persian War and its Preliminaries. By G. B. Grundy. Pp. xiii + 590. (London: John Murray, 1901.) Price 21*s.* net.

MR. GRUNDY has laid students of Greek history under an obligation by this work, but the obligation would have been greater if the bulk and price of the book had been less. The author seems, indeed, to have fallen between two publics. The scholar, who knows the literature of the subject, ancient and modern, will complain that he here labours the obvious and there ignores the essential, that his acquaintance with Greek history is superficial and his estimate of authorities uncritical, that the pages which present anything at once new and valuable are few out of many. The general reader will require more literary skill and lucid order in the story, and cannot be blamed if he prefers Herodotus in his native simplicity.

But it is probably neither as literature nor as history that Mr. Grundy would have us judge the book, but as a contribution to the topography of Greece and an essay in military criticism. Here he has done excellent service. The large-scale surveys of Thermopylæ and the field of Platæa are good bits of work, and will put the detailed discussion of those battles on a new plane. Mr. Grundy's topographical sketches are a welcome supplement to the maps, and show him to be no mean draughtsman. Most of them are better than the photographs with which they are interpersed, some (for example, the views of Marathon at p. 163, of Artemisium at p. 264, of the sound of Salamis at p. 392, of the panorama from Platæa at p. 502) are admirable pieces of line drawing.

To come to details, we could wish that the map of Thermopylæ covered more ground, even at some sacrifice

of scale. In the pass itself the mound and the Phocian wall are the only debatable points, and they might have been relegated (if necessary) to a little inset plan. (It is ridiculous, by the way, to treat the pretty story of the Spartans combing their hair as serious evidence for topography or "autopsy"—the other Greeks had to be invisible and the wall was a good excuse for hiding them, that is all!) But the real problems are concerned with the valley of the Asopus, the road into Doris, the site of Trachis and the path Anopæa, about the identification of which we have sometimes felt doubts. There must be a railway survey of the valley somewhere, which would give a base to work from, but Mr. Grundy is here less helpful than M. Hauvette, and does not even elucidate his own text—where, for example, is the Great Gable (p. 302)? Why is not Trachis the same as Heraclea, or its acropolis? What is the point of the polemic against Leake, who seems to have accomplished the not unprecedented feat of riding at six miles an hour? There is a useful note on p. 262 to show that "it seems to have been a recognised principle in later times that an effective defence of Oeta included the occupation of Heraklea as well as of Thermopylæ." But why not in earlier times too? Surely, if topography is worth anything as a test of the narrative of Herodotus, it points here to a serious omission.

Mr. Grundy has perhaps scarcely sufficiently guarded himself against the natural tendency to fix sites and positions on the authority of Herodotus and then triumphantly claim that the evidence of the topography confirms the story. We believe that he is right in his theory as to the "Island" at Platæa, but where the identification of so many points is so uncertain we cannot avoid an uncomfortable notion that a turn of the spade may any day undermine his whole construction of the campaign, not to say the narrative of Herodotus itself.

On the other battles of the war Mr. Grundy has little that is new to contribute and scarcely anything of a geographical character. His theory of the campaign of Marathon is essentially Busolt's early view, recently revived by Mr. Munro, of the battle of Salamis a development of Prof. Goodwin's. He scarcely seems to appreciate the full significance of the position at Artemisium, which covers all the landing-places between Tempe and Attica. Aphetæ is a dubious point. It is hard to reconcile Mr. Grundy's situation with the remark of Herodotus, that the wreckage of the first sea-fight drifted *out* to Aphetæ, which is badly misrendered in the words "was thrust in upon the Persian fleet." Mr. Grundy is much put about to find a reason for the Greeks taking the offensive in 479. He concludes that they feared the establishment of a Persian frontier at Cithæron. Obviously the Persians would keep all they could conquer, but why should they stop at Cithæron? and is not the real difficulty the Greek *delay* in taking the offensive after the victory of Salamis had entirely changed the situation?

Where Mr. Grundy has seen with his own eyes he generally has something useful to say, but where he has not seen he cannot always be trusted. It is an absurd exaggeration to call the Taurus an "all but blank impassable wall"; and other references to it would certainly suggest that it runs north and south! The theory of the weak strategic situation of the Asiatic Greeks will not hold where any communication by sea is so much better than any by land as in western Asia Minor. Was it either land or sea that divided, *e.g.*, Samos and Miletus? For downright geographical nonsense it would be hard to beat the description of Pteria as "a town whose position renders it the chief strategic point in the Halys region, commanding, as it does, the middle portion of the cleft-like valley through which the river flows" (p. 15). Mr. Grundy does not appear conscious of all the difficulties which beset Xerxes' march through Thrace as conceived by Herodotus. They do not harmonise well with his doctrine that the historian had himself traversed the road.

In the early chapters, the author makes great play with the idea of the "Ethnic frontier." As applied to the Persian attacks on Greece this is no novelty; but will it explain the conquest of Thrace? Are Phrygians and Bithynians still to be called Thracians in the days of Darius?

The book is sumptuously got up. It is a pity that so many misprints have been overlooked. Some of these are very unfortunate, *e.g.* banaustic (p. 94), St. Demetrion (three times), Elataea (four times), Oeroe with initial diphthong (always). Xerxes on p. 69 ought to be Darius. On the map of Marathon, Kynossema ought to be Kynosoura. On p. 350, Mr. Grundy has interchanged *east* and *west*—did he "alter his point of view"? On p. 378, a whole paragraph is based on a childish mistranslation of Herodotus.

In conclusion, we must heartily thank Mr. Grundy for publishing the many exquisite sketches by Edward Lear. They are as accurate as they are beautiful, and even had this book no solid merits of its own to recommend it, they would suffice to make it valuable.

GEOMETRY ON THE SPHERE.

Spherical Trigonometry. By the late I. Todhunter, M.A., F.R.S. Revised by J. G. Leathem, M.A., D.Sc. Pp. xii + 275. (London: Macmillan and Co., Ltd., 1901.) Price 7*s.* 6*d.*

THIS volume gives a systematic treatment of the subject of spherical trigonometry, based on the sound foundation of Todhunter rearranged and amplified. While the merit of the original work is sufficiently indicated by its vitality, the preface bearing the date 1859, it is natural that a text-book designed for the use of students forty years ago should to some extent fail to satisfy the requirements of the present day.

The subject falls naturally under two heads, (1) Formulæ connected with the Spherical Triangle and the Solution of Triangles, (2) Spherical Geometry. In both departments the reviser has used skill and judgment in grafting fresh shoots on the old stock, and has produced a homogeneous and well-balanced volume, double the size of the original and worthy to take its place among the best of our modern text-books. In trigonometry proper, Todhunter's treatment has been rendered very full and thorough. The theory is illustrated by well-selected numerical exercises, fully worked out and presented in the most concise form with due attention to labour-saving devices. Critical and ambiguous cases are carefully considered, discussed and illustrated diagrammatically, while

the practical methods and terminology used in navigation receive some notice.

In the department of spherical geometry more extensive additions have been made. New chapters have been added on Properties of the Spherical Triangle, Properties of Circles on the Sphere, The Principle of Duality, Hart's Theorem, The Generalised Triangle, The Application of Determinants to Spherical Geometry, while some additions and modifications have been introduced elsewhere. The chapter on the principle of duality gives an excellent *résumé* of the subject, illustrated by the exhibition in parallel columns of corresponding properties of a co-axal system of circles on the sphere and its dual a co-lunar system. The principle is also utilised in what the reviser styles, in the preface, a new treatment of Sir Andrew Hart's very striking and fertile theorem that the inscribed and escribed circles of a spherical triangle touch a fourth circle besides the three sides of the triangle. The bearings of the principle of duality on Hart's theorem have, however, been already discussed, and Dr. Leathem's treatment does not seem to add much that is essentially novel. The proof of the theorem, as here presented, appears, indeed, to be open to objection; the proof in § 178 of the condition for the contact of a given circle with the circumcircle of a given triangle assumes that the circles have a *real* limiting point L, while in §§ 203 and 204 all that has been proved is that the cone joining the circle H to the centre of the sphere touches, internally or externally, the inscribed and escribed circles of the triangle—an appeal to the particular case of the equilateral triangle, without further discussion, in order to determine the nature of the contacts hardly carries conviction. The plane analogue of this mode of treatment of Hart's theorem may be found in Lachlan's "Modern Pure Geometry," pp. 206 and 250, where also an adaptation to plane geometry of the theory of duality on the sphere is given at p. 257. Needless to say, the subject admits of wide development.

Among the chapters devoted to spherical geometry, one dealing with inversion, stereographic projection, &c., would have been welcome, but it was possibly excluded by want of space.

In the new chapters admirable judgment is displayed in the selection and arrangement of materials from a wide range of original sources, numerous historical and bibliographical references forming an excellent feature of the work. The style throughout is clear and attractive, and most of the examples which have been added possess the merit of elegance and real scientific interest. A. L.

A CONSUL IN CHINA.

John Chinaman and a Few Others. By E. H. Parker. Pp. xx+380. (London: John Murray, 1901.) Price 8s. net.

THIS is an interesting book of personal reminiscences during a long official residence in China. Mr. Parker served in the consular service for many years at a time when our relations with the Flowery Land were even more precarious and uncertain than they are to-day, and it is interesting to observe how under these conditions, and with Sir Harry Parkes as our Minister at Peking, a spirit of self-reliance was engendered among all holding authority at the outlying ports. The riots directed against foreigners which are now occasional were chronic in the 'eighties, and Mr. Parker came into a fair share of them. Being ever ready to accept responsibility, he in most cases undertook the defence of his countrymen during the acute stages of the crises, and when the hurly-burly was over arranged with the local authorities for the necessary punishment of offenders and compensation for the destruction of property. As he remarks, after describing a serious outbreak at Wênchou,

"The moral of this story is that Chinese nerves are so constructed that every Mandarin seems to have in him the makings of a murderer or a saviour, accordingly as the tide in the affairs of men is taken at the flood or on the ebb; that rows are seldom so dangerous or so serious as their noise and appearance is (*sic*) appalling; and that a readiness to make allowances for foolish human nature is commonly appreciated at its full value on the Chinese side. The same missionaries had to take refuge on the island once more dur ng the Boxer riots of 1900, but I see that my sensible and accomplished successor has been able to abstract ample compensation in the same friendly spirit as that evinced sixteen years ago. I see no reason why the whole Chinese question should not be treated on analogous lines."

To the principle here involved we entirely agree, but, unfortunately, the whole Chinese question has to be settled, not by one plain-dealing man, but by a dozen plenipotentiaries whose interests are conflicting, and some of whom find in a disturbed China a prospect of the realisation of their best hopes.

Another source of diplomatic difficulty at the present time is the absence of sound statesmanship at Peking. In the 'sixties, as Mr. Parker points out, there were men like Prince Kung, Wên-Hsiang and Kui-Hsiang, who were giants in comparison with the Prince Chings of the present day. Sir Thomas Wade used to call Wên-Hsiang "the last of the Manchus," and it is difficult to point to another of the race who has risen to anything like the same level of wisdom and knowledge.

But Mr. Parker has much to say of the Chinese and their affairs outside the political arena. He mixed more with the natives and gained a better insight into their characteristics and peculiarities than most Chinese-speaking foreigners, with the result that he has much to say in their favour and many strange peculiarities to note. Among the latter he mentions the curious tendency there is among the people to commit suicide.

"Women are the chief delinquents, or heroines, as they often imagine; it only needs a harsh word or a fit of passion, when down goes an ounce of opium—a most comfortable death. It will be noticed that the recent Boxer troubles are responsible for the suicide of at least a score of prominent statesmen. In some cases whole families have dived head foremost into wells in order to share the master's disgrace or self-sacrifice. In others the Emperor has 'bestowed the cord'; which means that a man sits with his back to a panel and his friends strangle him through two holes. So far from being considered a crime, suicide is under many circumstances regarded as a noble act; rarely as a despicable one, unless done in pure spite, or out of revenge."

The position of women in China is well illustrated by the many stories the author has to tell of native life, and the conclusion at which he arrives is that on which all close

observers are agreed, viz. that they have much more power in their households than is generally supposed, and that their status is universally recognised by all heads of families who desire to lead quiet lives. Mr. Parker quotes the case of a Captain Ch'ên as an illustration of common official domestic affairs.

"He"(Captain Ch'ên) "had a wife—*passée* of course—who ruled the roast in that watchful and relentless way in which capable French women *d'un certain age* rule a busy café. Captain Ch'ên bought, sold, and exchanged concubines freely, this freedom evidently being the common basis upon which agreeable terms had been made between himself and his wife.... Like a sensible man, he always showed formal respect to his wife; and, although he never took her to the various forts, camps, and war junks in or on which he was from time to time employed for months at a stretch, he always consulted her; left the purse strings in her charge; and gave her feminine command over all the concubines and 'slaveys' not actually with him."

Mr. Parker evidently has the gift of tongues, and finds it equally easy to communicate with the natives of Peking, the Hakka people of Canton, and the speakers of half a dozen or more dialects throughout the Empire. In the present work we have the results of this polyglot ability, and in a succession of short chapters, or notes, he throws countless side-lights on the kaleidoscopic aspects of the Chinese question and the social life of the people.

OUR BOOK SHELF.

The Home-Life of Wild Birds. By F. H. Herrick. Pp. xix + 148. (New York and London: G. P. Putnam's Sons, 1901.) Price 10*s.* 6*d.* net.

IN this attractive and beautifully illustrated volume the author lays claim to having invented a new method of studying and photographing birds in their native haunts; and he is certainly to be congratulated on the success of his efforts. Although his method of working is somewhat different, Mr. Herrick may be said to have done for some of the commoner birds of North America what has been effected by the Messrs. Kearton for those of Britain; and higher praise than this it would be difficult to bestow. To the English reader the book will be especially welcome, as throwing a flood of light on the habits of species with which he is necessarily unfamiliar. Among the most successful of the author's efforts are his photographs of cedar-birds, or waxwings, with their nests and young, which illustrate in full detail the mode in which the nestlings are fed and tended by their parents, and the curious postures assumed by the latter in the course of their duties. The attention devoted by these birds to their offspring is well indicated in the following passage, where it is stated that, on one occasion, "with half-spread wings and with back to the sun the mother protected her little ones for a full hour from the broiling sun, while her mate came repeatedly and handed out the cherries."

Instead of photographing from a long distance, or with a camera placed near the nest and worked by the observer from a distance by means of a string, the plan adopted by the author is to bring the nest and its surroundings within a short distance of the observer, who is himself concealed. If the nest be situated on a branch at a considerable height from the ground, the bough is carefully cut off and fixed, with the nest, in its natural position near the ground in a good light. If, on the other hand, the nesting site be a tussock of grass in thick coppice, the whole mass is dug out and transplanted to the open. The photographer takes his station in a green tent, through a hole in the canvas of which the camera can be brought to bear on the nest and its surroundings. When the nest is in a situation to which the tent can be brought near, and where the light is good, its natural position is not interfered with, and only such boughs as obstruct the view are cut away.

It might be thought that the removal of a nest and its surroundings from a height of 40 feet to within a yard or so of the ground, or from the shade of a dense coppice to the glare of sunlight, would seriously disturb the parent birds. This, however, according to the author is not the case if proper precautions be taken. "No injury," writes Mr. Herrick, "is wrought upon old or young. The former nesting conditions are soon forgotten, while the new are quickly adopted and defended with all the boldness of which birds are capable."

The method is at present only in its infancy, but by its aid we may hope in time to have permanent records of the complete life-history of a large number of birds during their nesting-seasons.

R. L.

Finishing the Negative. Edited by George E. Brown, F.I.C. Pp. 160. (London: Dawbarn and Ward, Ltd., 1901.)

ALTHOUGH there are many very excellent handbooks on photography in general, there are few which give so much useful and necessary information regarding the treatment of the photographic plate after the negative has been obtained. Many amateurs consider the negative ready for printing after a few spots have been obliterated and perhaps a small retouch here and there; but a glance at this book gives one the idea that the negative is by no means ready for printing, but may be improved (in the case of beginners probably not) by many of the numerous hints here brought together. The separate chapters of this book are devoted to the manipulations of drying, hardening, clearing and removing stains, different methods of intensification and reduction, softening and increasing contrasts, varnishing, stripping, retouching portrait negatives, handwork on back and front of negative, spotting and blocking out, and many other aids to producing a "perfect" picture, concluding with special hints for applying the above processes to the working of celluloid and stripping films.

The editor of the book tells us that in many of the chapters he has had the able help of several workers in these special lines of work, so that the reader will find the hints both practical and instructive.

The book will certainly fill a gap as regards the special branches to which it is devoted, and the many well-chosen illustrations considerably aid the text in showing the reader the "before" and "after" stages of many of the manipulations described.

Text-book of Elementary Botany. By Charlotte L. Laurie. Pp. ix + 142. (London: Allman and Son, Ltd., n.d.) Price 2*s.* 6*d.*

THIS little book supplies the information required for such examinations as the junior Oxford and Cambridge, and is specially adapted to a school curriculum. Despite some defects which are mentioned below, the author is to be congratulated on having written an elementary botany which shows some new features and by its character and conciseness avoids the dull level of most similar works. There is much that calls for favourable comment. The language is simple, and technical words are slipped in easily with derivation or other simple explanation; the illustrations are original, for the most part extremely good and well reproduced, and throughout the book an admirable balance is maintained—no easy matter when the compass is so small. There are three parts to the book, dealing with morphology, classification and physiology respectively. Very wisely, no attempt is made to treat of internal anatomy, so that all exercises can be worked out with the lens and scalpel. In the morphological part, useful summaries pick out at intervals the main data for description or comparison; also numerous ecological references are worked in. One must

regard the use of the terms "sporangium," "macrospore," "microspore" as unnecessary, seeing that the book deals only with the flowering plant; and why "oosphere" and not "ovum"?

In the second part short chapters explain the Linnæan and natural systems of classification, the distribution of plants, and give general directions for field work.

The physiology is the least satisfactory part of the book. The plan adopted of giving experiment, result and conclusions to be deduced therefrom is eminently good. But many of the experiments are open to serious criticism, as in some cases the apparatus is not practical, in others the deductions are unsatisfactory. For instance, apparatus is figured on p. 126 to show that plants take in oxygen. The apparatus shown would certainly allow leakage of air; the potash would not absorb much carbon dioxide, and in so far as it did, this would partly account for the change in the manometer; further, the seedlings shown in the figure would photosynthesise unless placed in the dark. The three subsequent figures also show apparatus which is not workable. Despite these faults and one or two erroneous statements, the book is so vigorous and well compounded that it may be strongly recommended to school teachers as one which is eminently suitable for beginners in botany.

Intuitive Suggestion. By J. W. Thomas. Pp. x + 160. (London: Longmans, Green and Co., 1901.) Price 3*s*. 6*d*. net.

IT is difficult to know how far Mr. Thomas takes himself seriously. His book is called a "New Theory of the Evolution of Mind," and certainly contains some very novel and curious statements both about the past and about the future of mankind. He has, however, no very clear notion of the difference between saying a thing and proving it, and many of his most remarkable assertions are made without any serious attempt of proof. His main thesis appears to be that the processes of the inorganic and organic worlds alike are the consequences of a series of quasi-hypnotic "suggestions" on the part of a "great first cause." He takes, that is, a few unfamiliar and very imperfectly understood facts of experience and makes them the basis of a theory of experience as a whole. Apparently he has never even asked himself whether there is any evidence to show that a creature without a nervous system would be amenable to "suggestion" at all. The argument from the miraculous narratives of the Bible, on which he lays great stress, is deplorable alike from the standpoint of logic and of piety. From the logician's point of view, the alleged facts are insufficient as a basis for a theory of nature, and from that of the believer they lose all their moral significance by being degraded to the level of mediumistic or hypnotic "phenomena." A. E. T

Jahrbuch der Chemie. Herausgegeben von Richard Meyer. Jahrgang, 1900. Pp. xii + 565. (Brunswick: F. Vieweg und Sohn.) Price 15 mk.

THOUGH somewhat later in the time of its appearance, this valuable publication is happily not much thicker than its precursors, and the volume before us gives in reasonable space an excellent summary of the chief advances in chemistry and applied chemistry recorded in the year 1900. The labour of writing is distributed among authorities of the highest competence, and the result is correspondingly satisfactory. It is true that the information is in a highly condensed form, but the present writer is able to say of the subjects on which he is at all qualified to speak that they are dealt with in summaries which bear the impress of informed writers rather than hack abstractors, and that they will continue to serve well the useful purpose of assisting all those who are engaged in the difficult task of keeping themselves moderately well informed of chemical progress.

A. S.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

Earthquake Observations in Strassburg.

DURING the last twelve months, on more than one occasion I have been asked why it is that at the Kaiserlichen Hauptstation für Erdbebenforschung in Strassburg one type of instrument records earthquakes so very much more frequently than other types of instruments give records, although they are all installed in the same building. An answer to this is apparently to be found in an analysis of the Strassburg registers.

For example, in January 1901, a von Rebeur-Ehlert apparatus, which consists of three horizontal pendulums oriented at 120° to each other, which reflect beams of light on to a photographic recording surface at a distance of about three metres, yielded twelve records, only five of which were noted by a single component horizontal pendulum of the type adopted by the British Association and now in use at very many stations round the world. This latter apparatus was therefore quiescent on seven occasions when we should have expected it to have been in action. On looking at the registers, we first observe that these seven disturbances were all exceedingly small, and two of them were only noted in Strassburg. Considering this latter fact, in conjunction with the facts that they are found in the traces from an instrument with a very high multiplication, subject to so-called "Mikroseismische Unruhe" (air tremors?), and that a blur may be formed in the photographic record by a slight flare in the illuminating apparatus, it seems a bold proceeding to enter such records (January 17 and 26) as being earthquakes. I doubt their seismic character and consider that their entry ought to have been accompanied by some qualification. So much for two out of the missing seven. Two others (January 8 and 30), although not recorded by the British Association type of instrument in Strassburg, were recorded by similar instruments in Britain and at stations in other parts of the world. That they were not recorded in Strassburg, but were recorded all round Strassburg, suggests the idea that the instrument as installed at the Hauptstation has not the desired amount of sensibility, and if this is the case it is not remarkable that this form of instrument as used in Strassburg should fail to record very small earthquakes.

As another illustration let us take the month of August, when the Rebeur-Ehlert pendulums gave twenty-four records, out of which the British Association seismograph is advertised as only having responded to four. A glance at the registers for stations in Britain and other countries shows that this number should be increased to seventeen, leaving a balance of seven, which, if they all are earthquakes, are for the most part peculiar to Strassburg, and as such have in my own mind a doubtful character.

Another point connected with the Strassburg registers relates to the determination of origins. To identify a seismogram obtained at Strassburg on September 17 at 4.30 a.m. as connected with an earthquake which shook a small portion of the north of Scotland at about 1.25 a.m. on that morning is asking us to believe more than our reason can accept. Even had the Hauptstation been situated in the south of Scotland itself, it is very doubtful whether its horizontal pendulums would have responded to a local shock originated in the northern part of the same country. JOHN MILNE.

March 3.

Proofs of Euclid I. 5.

SEVERAL writers have lately expressed their opinions in favour of replacing the present proof of this proposition by an alternative proof based on the supposition that the bisector of the vertical angle of the isosceles triangle is drawn, irrespective of the fact that no construction has been given for drawing this bisector. Now there may be some advantage in using a "hypothetical construction" to prove a proposition, where its avoidance necessitates a long and tedious alternative proof. In the present instance the artifice is absolutely unnecessary, as the proof can be simplified in any of the following ways, A being the vertical angle of the isosceles triangle ABC:—

(1) By adopting Euclid's construction of cutting off equal segments AD, AE from the sides and proving as he does that the triangles ABE, ACD are equal in all respects, and then making D, E coincide with A, B respectively. The method of passing to limiting cases is highly instructive, the only question being as to the advisability of trying to introduce it to beginners, except as an experiment.

(2) By drawing a duplicate DEF of the triangle ABC (this operation being only a slight extension of the method of superposition used by Euclid in I. 4), and proving first that $\angle A = \angle E$ and $\angle B = \angle F$, and second that $\angle A = \angle F$ and $\angle B = \angle E$.

(3) By *folding the triangle* so as to bring AB into coincidence with AC. This is *practically* equivalent to bisecting the vertical angle, but it replaces a "hypothetical construction" by an operation which the beginner can easily perform.

The method of folding has many obvious advantages, and much would be gained if beginners could be taught at once to recognise cases in which one half of a figure could be brought into coincidence with the other half by folding. For example, the property that the common chord of two circles is bisected at right angles by the line joining the centres is obvious when it is recognised that one half of the figure is the fold of the other half. The method is, moreover, hardly more artificial than the method of superposition which Euclid himself employs.

It should be noticed that Euclid's proof of I. 4 involves an assumption which I have never seen pointed out, namely, that *two straight lines cannot touch one another*. If this be not assumed, then when the sides DE and AB are brought into coincidence, the sides DF and AC do not necessarily coincide even though they make the same angle with the same straight line and on the same side of it. G. H. BRYAN.

The Zodiacal Light and Sun Pillars.

THE appearance on clear evenings of the zodiacal light *after* sunset at this season of the year in this latitude is usual, and it has been frequent and beautiful to observe in this district for many nights. It would be interesting if the readers of NATURE could detect any definite movement of the arm of light, for much yet remains to be discovered about this phenomenon, and any observer can make this point a study. From a short half-hour after sunset to from 8 to 9 p.m., a straight line drawn from the sun's position at sunset to the Pleiades will not remain the centre line of the zodiacal light. It appears to emanate from the sun and move as the luminous spoke of a wheel which has the sun for centre frequently, but not invariably. What makes the light apparently fade away? Is it that the motion of the earth has drawn with it the arc of volcanic or meteoric particles, which may be the medium of the light, away from the sun? or is it not possible that such a band of dust is lit with a degree of earth-shine? If so, may not this account for that other phenomenon of the Gergershein, which is usually brilliant in proportion to the brilliancy of the zodiacal light? Doubtless these phenomena are always present, but their visibility depends on the magnetic or electric condition of our atmosphere. Irritated by either of these conditions, the belts of dust would alter positions of all the bodies forming them, and so lie at a different angle and be clearer or dimmer accordingly.

The very remarkable sunset of March 6 has probably been observed by many readers of NATURE. The "fire-finger" left in a perfectly perpendicular position for upwards of fifty minutes after sunset was visibly withdrawn, without losing colour or size or changing from the perpendicular, and was a vivid and beautiful adjunct to a sunset afterglow strangely reminding one of the "Krakatoa sunsets" of years ago. This finger of fire the writer has only observed once before, after a similar-coloured sunset over the estuaries of the Medway and Thames last summer, but London smoke dimmed the effect. This rare appearance seemed on March 6 to resolve or be replaced by five vivid *white* rays with slight wheel motions from north to south, the largest of which eventually seemed the zodiacal light itself.

GUY J. BRIDGES.

Sutton Mandeville Rectory, Salisbury.

A PHENOMENON was visible here this evening which I think deserves to be recorded. We have an uninterrupted view of the western sky, and about a hundred pairs of sharp eyes are available, so that any unusual sunset is pretty certain to be noticed. Solar halos are comparatively common occurrences, and I have come to the conclusion that lunar rainbows are not so rare as is believed, but the "pillar of fire" which has been visible here for at least forty minutes is the most brilliant sight I or any of my oldest friends have ever witnessed. It was first observed at 6 p.m. just after the sun had disappeared, and was exactly *vertical* over the sun. The colour was at first silvery (resembling a searchlight) and later a golden yellow, the width equal to the sun's diameter, and the length 18° to 20°. A few light clouds seemed to pass *behind* it. Some observers noted a flickering and also a swaying motion, but this may have been an optical effect. At about 6.30 the colour had changed by gradations into a deep crimson-red, and for the next ten minutes it gradually became deeper in colour and shorter, disappearing at 6.40.

I may add that on February 20, 1901, I observed a very faint trace of a similar phenomenon.

Can any of your readers direct me to any literature bearing on the matter? WM. A. KNIGHT.

Sexey's Trade School, Bruton, Somerset, March 6.

The Quadrantid Meteors.

MR. JOHN R. HENRY, according to his letters in NATURE of January 2 and 23, unfortunately looked out too late for the Quadrantids, owing to having miscalculated the time of maximum, the approximate probable time of which might also have been obtained from the British Astronomical Association. He is right in saying that the date of the shower is advancing into the year, but the advance is slower than he thinks. Taking the data he gives, which, however, are only very rough, and also a consideration of the sun's longitude as given in the "Nautical Almanac," there is an advance of only five hours in the thirty-seven years 1825 to 1862. It would appear that in the forty years from then a further advance of probably about eight hours has taken place. It is unfortunate that Prof. A. S. Herschel has not published the exact number of meteors he saw from hour to hour on January 2, 1900, when he watched from 11h. to 16h. 30m. He, however, states that the frequency continued about the same during the whole period, and seeing the radiant point was rising all that period, this would mean that the maximum was near the beginning of his watch.

Mr. Henry may be right in saying that the period of maximum fluctuates somewhat from year to year, though the data he gives are not sufficiently accurate to prove this; but I fail to see what ground he had for expecting the maximum so late as he did this year. Taking all the data into consideration, we might have expected the maximum to be about 23h. on the 2nd. I see no reason to doubt that this expectation was fulfilled; but as the maximum would occur in the daytime, observations in other countries would be necessary to prove this. The Quadrantids as seen here were most numerous on that morning.

It seems probable, therefore, that the time of the next maximum will be about 5h. on January 3, 1903. T. W. BACKHOUSE.

West Hendon House, Sunderland, March 5.

Elementary Mathematics.

I WAS very glad to read in NATURE of January 30 (p. 297) the letter of Mr. J. W. Marshall on elementary mathematics, because all his suggestions referring to elementary algebra have already been realised in my book, "Applied Algebra," published in 1900 at St. Petersburg, in Russian.

I send, therefore, two copies of my book, one for the editor, the other for Mr. Marshall. The algebraical characters will permit every mathematician to judge somewhat of the character of a mathematical book without a knowledge of the Russian language. My compatriots have already condemned my heresy; but I hope that my ex-compatriots (our family is of Scottish origin, derived from Lehrmouth) will judge more liberally my attempt to improve the old method of teaching the prolific science of algebra.

The peculiarities of my exposition are explained by the fact that I wished to say all that was needed, and only what was needed. For that purpose it was necessary to put in the first place the systematical exposition of all the most fundamental methods of algebra which are sufficient for ordinary applications, and to postpone to a supplement all complicated questions that are usually combined with fundamental notions in the existing manuals, only producing a confusion in the minds of the pupils.

Before attempting to expound a new section, I endeavour to explain the purpose which this section serves, for as King Solomon stated: "A fool hath no delight in understanding, but that his heart may discover itself." (Prov. xviii. 2.)

In small type I have given many of the explanations that a good teacher requires with his pupils in the class room, but never includes in his printed manual. This peculiarity makes my book useful for self-instruction.

The beginning of all mathematical study is easy. The difficulty begins later, because it is indispensable to know what has already been studied for the understanding of what follows. Therefore my arrangement permits even the youngest pupils to learn something applicable to the practice of calculation.

WALDEMAR LERMANTOFF.

University of St. Petersburg, Russia.

THE NATIVE QUESTION IN SOUTH AFRICA.[1]

It cannot be too often repeated or too strongly impressed on the public mind of this country that by far the most difficult problem of South Africa is, not that of the relations of the white populations to one another, but that of the relations of the white population to the "Natives," and of the Natives to one another. It involves questions not to be solved by any process of patching. The ordinary "short view" recommended by European statesmen in treating European problems will not do. To deal with these questions effectually, considerations of a far-reaching economic and anthropological character are necessary. We must understand the Native mind, we must endeavour to see things from the Native point of view, we must consider the Native prejudices and aspirations as well as what we, from our point of view, regard as the Natives' best interests, and we must take into account their physiological and mental condition, and the influence upon it of the changes which have begun and the further changes impending.

It is thus evident that, before any final steps can be taken, a full inquiry into these matters must be held. Until the end of the war such an inquiry would be difficult. Consequently, all that can be done at present is to legislate on the most urgent points, so as to obtain a temporary *modus vivendi* on the labour contracts and the liquor laws. This is all that Lord Milner has yet attempted. But his despatches to the Colonial Secretary, and the important memorandum by Sir Godfrey Lagden, comprised in the papers recently presented to Parliament, though relating chiefly to the proclamations on the two subjects just mentioned, disclose the fact that the authorities are not insensible to the wider principles which must underlie our future policy. Lord Milner fully recognises the need of uniformity throughout British South Africa, and looks forward to a Native code to be framed by a Federal Parliament. It is satisfactory to learn from him that "the best colonial sentiment" as to our treatment of the Natives "is not far removed from the best home sentiment, as represented, for instance, by temperate and reasonable advocates of Native rights," such as the authors of "The Natives in South Africa," reviewed in these columns last May. What is wanted is that such sentiment should be controlled and directed by full and accurate information.

The Anthropological Institute and the Folklore Society have already petitioned Mr. Chamberlain to order a full and systematic inquiry into the Native laws and customs in our new colonies at the earliest possible moment. The authors of the book just referred to, whom Lord Milner mentions with so much approval, speak of the want of such an inquiry as "urgent." It is the only satisfactory way to provide the information required for the guidance of public sentiment, and of the administration; and if the example of Cape Colony be of value, it must precede any comprehensive attempt at legislation. The readers of NATURE are primarily interested in its scientific aspect. It is needless to reproduce the arguments they have had before them more than once. Those arguments are reinforced by Lord Milner's protests against some of the statements made on behalf of the Anti-Slavery Society and the Aborigines Protection Society in these papers, and by Sir Godfrey Lagden's admission that "there is much yet to be learnt by those who are vested with the control of Native affairs." And, though there is no allusion to the matter in the despatches now printed, we may be allowed to indulge the hope that it will not be overlooked as soon as the country is sufficiently pacified to enable the Government to arrange for it. Meanwhile, every opportunity should be taken by scientific anthropologists and jurists to bring their views before ministers and members of Parliament.

[1] "Transvaal. Papers relating to Legislation affecting Natives in the Transvaal." Presented to Parliament, January 1902.

THE JUBILEE OF THE AUSTRIAN METEOROLOGICAL CENTRALANSTALT.

To celebrate the fiftieth year of the existence of the Central Institute for Meteorology and Earth's Magnetism, the Vienna Academy has published a jubilee volume,[1] the contents of which form a very valuable contribution to science and an appropriate publication for this important celebration. This Central Institute, which is now the hub of all the meteorological and magnetic work carried on in the Austrian Empire, came into existence on July 23 in the year 1851, and it was founded with the object, first, of coordinating a number of stations all over the country and making them work on a uniform plan, and, second, of collecting such observations. How well these two objects have been carried out is familiar to every meteorologist of to-day, and so successful an issue of this organisation has been due to the consecutive labours of such directors as Kreil, Jelinek, Hann and Pernter, who have kept the Institute in such an excellent state of efficiency.

In the present volume we are first made acquainted with a brief history of the events which led up to the formation of the Institute, and the progress made during the period of office of each director. This is written in the form of an introductory chapter by the present director, Prof. Pernter. It is interesting to read that in the year 1851 Director Kreil had only forty stations working on a uniform plan carefully prepared by the Institute, but eleven years later he had increased the number nearly threefold. At this early stage there was a great amount of work to be accomplished, and Kreil, among other things, brought out the useful and valuable year book which was considered at the time a "modèle a suivre." The collection of old observations formed an important duty at this period of the Institute's history, and the first few volumes published contained long series of valuable observations made at Wien (1775–1850), Mailand (1763–1850), Prag (1775–1851), Kremsmünster (1763–1851), Salzburg (1842–1851), Udine (1803–1842), Fünfkirchen (1819–1832), Stanislau (1839–1850), and several other stations.

As time went on, the Institute, like many others, began rapidly to accumulate more work than it could accomplish, and this necessitated an increase in the staff and a greater output of publications. By the year 1877, 238 stations were sending in their results, while twenty years later this number had increased to 447; last year the number of first, second and third class stations together was 420.

To come now to the series of valuable articles which form the substance of this large volume, it may, in the

[1] "Denkschriften der kaiserlichen Akademie der Wissenschaften." *Mathematisch-Naturwissenschaftliche Classe*, vol. lxxiii.

first place, be remarked that as these cover no less than 600 pages, only a very brief reference can be made to each of them.

The first contribution, by the distinguished late director of the Institute, Hofrath Julius Hann, is a masterly discussion of the meteorological observations made at the Institute during the years 1852–1900. This paper brings together the monthly and yearly means of each of the meteorological elements during this period, and in two cases—namely temperature and rainfall—the data given extend back to 1775 and 1845 respectively. Such a long series of temperature observations has enabled him to investigate them for secular variations, with the result that he has found the anomalies to conform to a variation having a period of thirty-five years. It may be of interest here to mention that quite recently Hann has shown (*Kais. Akad. d. Wiss.* Jahrg. 1902, No. 1, p. 5) that the rainfalls of Mailand, Padua and Klagenfurt have also a secular variation of thirty-five years, the years of maxima and minima corresponding with Bruckner's epochs.

Next follow two papers relative to the "Föhn." The first is by Dr. Paul Czermack, in which he describes some experiments that serve to illustrate details in the behaviour and appearance of these currents. The second communication, by Dr. Robert Klein, deals with the daily variation of the meteorological elements at Tragoss due to the occurrence of the "Nordföhn," and he finds that all the elements are regularly disturbed by it, and offers an explanation for these variations.

The influence of the "Bora" on the daily period of some of the meteorological elements is discussed by Herr Eduard Mazelle. The observations were made during the years 1886–1895 at the astro-meteorological observatory in Trieste, and the results indicated that the elements changed definitely on these occasions.

A comparatively short paper, by Dr. Victor Conrad, describes the experiments and observations that he has made to investigate the water capacity of clouds and mists. In the first instance he devoted his time to the study of the "aspirationsmethode," producing artificial mists by means of a small boiler. The author then applied this method to natural clouds and mists, making his observations at elevated stations such as Schneeberg, Waxriegel (1884m.), Schafberg (1798m.), and Hohen Sonnblick (3106m.). The results are a distinct advance on earlier determinations, and, in addition, serve to explain some anomalies previously observed by other workers; thus, to take one case, the curve illustrating the relation of the water capacity to the "seeing distance" (in the mist) in metres shows clearly the difficulty of measurement of the water capacity when the seeing distance reaches about 150 metres.

We come now to two papers dealing with the daily variation of the temperatures in Austria and at Vienna (Hohe Warte), by Drs. J. Valentin and Stanislav Kostlivy respectively. Both these communications are exhaustive investigations on these meteorological elements, but even a brief reference to them must be omitted.

Dr. J. Pircher is the author of an important memoir on the hair-hygrometer. He first discusses the hair from the point of view of a hygroscopic substance, and describes in detail the features and peculiarities of different hair-hygrometers. This is next followed by a minute experimental investigation of the hair-hygrometer and its capability of indicating efficiently the phenomena it is intended to record. Comparisons of the hair-hygrometer with the condensation hygrometer of Alluard, with the psychrometer, the aspiration psychrometer of Assman, &c., are then given, concluding with deductions as to the sensitiveness of the hair-hygrometer and the influence of the action of direct sunlight upon it.

Some of the results at which the author has arrived, to put them in a few words, are, that the relative humidity can under all circumstances be measured to within five per cent., but in most cases to three per cent.; that the efficiency of the instrument is considerably decreased if it be allowed to stand for a long period of time in a room of constant humidity, it being pointed out that it is not only advisable, but necessary, to occasionally moisten the hair; and, finally, that temperature (with the exception of direct sunlight) and wind velocity have no effect on the instrument, while no variation was observed in the case of pressure.

A valuable paper by Prof. J. M. Pernter gives the results of some interesting experiments on the polarisation of light in cloudy media and their connection with the present explanation of the blueness of the sky. This investigation was undertaken to answer, if possible, the question whether the light of the sky (Himmelslicht) considered as scattered light of a cloudy medium, and the blue of the sky (Himmelsblau) as the colour of a true medium, could be more easily and, perhaps, also finally answered by the behaviour of light in relation to polarisation than by measurements of the intensity of single colours, since the latter, both with artificial cloudy media and with skylight, are connected with great experimental difficulties. Prof. Pernter used for the media different percentages of liquids coloured in such a way that he could employ all gradations of colour from the finest blue to a tone of milky white. Through these liquids he allowed rays of different colours to pass, and examined them after transmission by means of a polarimeter. In the summary of the results arrived at it will be seen that an important step in advance has been made from the experimental standpoint, and the observed facts are in harmony with the well-known theory of Lord Rayleigh.

The last two papers in the volume, which can here only be referred to by their titles, are written by Drs. Max Margules and Wilhelm Traberto, and are on "The Value of Work (Arbeitswert) of a Pressure Distribution and on the Preservation of Pressure Differences" and "Isotherms of Austria" respectively. In the latter the author has used, whenever possible, the fifty-year means of temperature, and has employed the values obtained from 773 stations in Austria and 142 outlying places; the maps accompanying the paper illustrate the isotherms for the months of January, April, July and October, the isotherms for the whole year, together with four other maps showing the isotherms for special regions.

In bringing this necessarily brief digest of the contents of this important volume to a conclusion, one cannot but call to mind the very valuable service this Central Institute of Meteorology has rendered to meteorological science in general. The numerous voluminous publications which have issued from its doors, and the very able help it has provided and still provides in many directions, are sufficiently well known to indicate the great activity that is displayed in its various departments. The publication of the volume before us is not only a fitting outcome of such labours, but is a worthy tribute to the memory of those who have striven to place the Institute in the first rank, in which it stands to-day.

W. J. S. L.

THE OWENS COLLEGE JUBILEE.

ON March 12, 1851, the Owens College began its existence in a modest house in the centre of Manchester which had formerly been inhabited by Richard Cobden. The College was removed to its present site in Oxford Street in 1873; since that date one addition after another has been made to the buildings, which now cover an irregular area of some 240,000 square feet.

The chemical laboratories have been twice enlarged,

notably in 1895 by the addition of the Schorlemmer laboratory; the engineering laboratory was opened in 1887 and has been greatly enlarged since; the large Beyer biological laboratories and the museum buildings were completed in the same year; the medical school was extended in 1883 and doubled in size in 1894; the Christie library was opened in 1898, the new physical laboratories (on a separate site) in 1900.

The Prince of Wales inaugurated the jubilee ceremonies of the College yesterday by opening the noble Whitworth Hall, which completes the large quadrangle of the College. It will be remembered that the late Sir Joseph Whitworth left the bulk of his fortune to Lady Whitworth, Mr. R. C. Christie and Mr. R. D. Darbishire, with absolute discretion as to the disposal of the money; of this more than 120,000*l.* has been given to Owens College by the legatees, jointly or severally. The late Mr. Christie, himself for many years a professor at Owens, after presenting the College with a beautiful library building from his private purse, gave in 1897 the residue of his share of the Whitworth bequest, amounting to about 50,000*l.*, for the building of a college hall, to be named after Whitworth. This hall, designed like the rest of the main buildings of the College by Messrs. Waterhouse and Son, is in the Gothic style, and is 120 feet long and 50 feet wide. It has a beautiful and elaborate high-pitched oak roof, of which the apex is 56 feet from the floor. The principals are supported on columns of granite. The sides of the hall are of polished stone with a panelling of polished oak. At the north end is an organ (the gift of Mrs. Rylands), encased in a fine screen of carved oak, and on a level with the organ loft, and adjoining it, are galleries for a choir. Immediately in front of the organ is a daïs, a few feet above the level of the floor. The hall is lighted by a series of stained glass windows on either side, and by a great window, in the perpendicular style, at the south end, in which the arms of the founder of the College and its chief benefactors have been inserted. The floor slopes slightly upwards from north to south, and at the extreme end of the hall there is a raised platform so that all can see the north daïs. Two small galleries are placed across the south corners of the hall, each adjoined by a short lateral gallery. The hall itself seats between nine hundred and a thousand persons. It forms the first story of the Whitworth building, of which the basement contains smaller rooms, destined for university offices, &c. There are exits into the museum and library, and also three exits on to Oxford Street and Burlington Street.

The order for the proceedings for the jubilee was as follows:—

Wednesday, March 12, 11.30, commemoration of the foundation of the College and opening of the Whitworth Hall, by H.R.H. the Prince of Wales (accompanied by H.R.H. the Princess of Wales); 2.15, luncheon at the Town Hall by invitation of the Lord Mayor of Manchester, and at the College by invitation of the College authorities; 8.30, reception at the College, by the president, the Duke of Devonshire, K.G., and council.

Thursday, March 13, 11.0, presentation of addresses of congratulation from universities and learned societies in the Whitworth Hall and conferring of honorary degrees by the chancellor of the Victoria University, Earl Spencer, K.G.; 7.30, dinner given by the College to delegates and to the governor and staff of the College.

Representatives from a number of foreign and colonial universities and learned societies arranged to be present, among them being the following:—Foreign universities and societies: Paris, Prof. A. Espinas; Lille, Prof. A. Angellier; Académie des Sciences (Institut de France), Prof. H. Becquerel; Munich, Prof. Hermann Breymann and Prof. K. Goebel; Göttingen, Prof. Walther Nernst; Göttingen (Royal Academy of Sciences), Prof. Voigt; Lund, Mr. Vice-Consul H. Ehrenborg; Geneva, Prof. Chodat; California, Prof. F. Slate; Western Reserve (Ohio), Prof. H. E. Bourne; Zürich Polytechnic, Dr. E. Knecht. Indian, Colonial universities and learned societies: McGill (Montreal), Lord Strathcona, G.C.M.G. (High Commissioner for Canada); Calcutta, Dr. William Booth; Bombay, Sir J. Jardine, K.C.I.E.; Madras, Mr. J. B. Bilderbeck; Cape of Good Hope, Mr. T. E. Fuller (Agent-General for Cape Colony); Adelaide, Prof. Hudson Beare. In addition delegates were sent by the universities of the United Kingdom, university colleges, and most of the learned societies.

It may be mentioned that at the opening of the College among the members of the staff, which consisted of a principal, four other professors and two teachers, were Archibald Sandeman, professor of mathematics; Dr. Edward Frankland, professor of chemistry; and W. C. Williamson, professor of natural history, botany and geology. There were sixty-two students in the first session. The staff now consists of the principal, Dr. Alfred Hopkinson, and thirty-one other professors and eighty lecturers and assistant lecturers; and the College has between a thousand and eleven hundred students in its various departments of arts, science, law and medicine.

NOTES.

WE regret to see the announcement of the death of Prof. Maxwell Simpson, F.R.S., formerly professor of chemistry in Queen's College, Cork, at the age of eighty-seven; and also of Mr. Bryan Donkin, a vice-president of the Institution of Mechanical Engineers, at the age of sixty-seven.

PROF. J. KUEHN, professor of agriculture in the University of Halle, has been elected a correspondant of the Paris Academy of Sciences, in the section of rural economy.

THE Raoult memorial lecture of the Chemical Society will be delivered by Prof. van 't Hoff on Wednesday, March 26, in the lecture theatre of the Royal Institution. The annual general meeting of the Society will be held on the afternoon of the same day.

AN interesting Easter excursion to the Gower Peninsula, South Wales, has been arranged by the Geologists' Association. The party will leave London on Thursday, March 27, and will return on Wednesday, April 2. The district is rich in fine rock scenery, instructive exposures and cliff sections, and splendid views, so that those who are able to take part in the excursion may be assured of a pleasant holiday.

THE Paris Natural History Museum celebrated on Sunday last the fiftieth anniversary of the publication of the first scientific memoirs of one of the most distinguished members of its staff, M. Albert Gaudry. He was honoured, says the Paris correspondent of the *Times*, as one of the most eminent evolutionists in France, in many respects a precursor of Darwin. It is he, in the words of M. Edmond Perrier, the director of the museum, who has virtually emancipated palæontology from the swaddling clothes in which its mother science, comparative anatomy, had endeavoured so long to keep it.

PROF. MELDOLA'S address on the coming of age of the Essex Field Club, which will be given at the twenty-second annual meeting, to be held in the Essex Museum, Stratford, on Saturday, March 22, should be worth the attention of those interested in naturalists' societies or desiring to encourage their efforts. A carefully digested record of the *local* scientific work carried on by the

Club and its members will be of great value. Since its foundation in 1880, the Society has published about 5000 pages of matter, three-fourths of which relates to the natural history, in the widest sense, of the county of Essex, and much of it is wholly original in character. Any reader desiring to attend the meeting should communicate with the hon. secretary, Mr. W. Cole, Buckhurst Hill, Essex.

A MEETING of the American Philosophical Society will be held at Philadelphia on April 3–5. Among the subjects of papers included in the preliminary programme are:—The International Catalogue of Scientific Literature, Dr. Cyrus Adler; recent progress in the lunar theory, Prof. E. W. Brown, F.R.S.; systematic geography, Prof. W. M. Davis; results of observation with the zenith telescope at the Sayre Observatory, Prof. C. L. Doolittle; the advancement of knowledge by the aid of the Carnegie Institution, President D. C. Gilman; the continuity of protoplasm, Prof. H. Kraemer; further experiments on the physiological action of ions, Dr. Jacques Loeb; wireless telegraphy, Mr. Guglielmo Marconi (if in America); distribution of fresh water decapods and its bearing upon ancient geography, Dr. Arnold E. Ortmann; evolution and distribution of the Proboscidea in America, Prof. H. F. Osborn; the relation of the American University to science, President H. S. Pritchett; South American mammals, Prof. W. B. Scott; historical investigation of the supposed changes in the colour of Sirius since the epoch of the Greeks and Romans, Dr. T. J. J. See; and biological heredity and organic evolution, Prof. Giuseppe Sergi.

THE ninth meeting of the Australasian Association for the Advancement of Science was held at Hobart on January 8–16, under the presidency of Captain F. W. Hutton, F.R.S., whose address on evolution and its teaching was abridged in last week's NATURE. The presidents of the sections and the subjects of their addresses were as follows:—Mr. R. W. Chapman (astronomy, mathematics, physics and mechanics), tidal theory and its application; Prof. A. M. A. Mica-Smith (chemistry and mineralogy), the study of the chemistry of the air, and whither it has led; Prof. T. S. Hall (geology and palæontology), the possibility of detailed correlation of Australian formations with those of the mother hemisphere; Prof. W. B. Benham (biology), earthworms and palæo-geography; Rev. Geo. Brown (geography), the Pacific, east and west; Mr. T. A. Coghlan (economic and social science and statistics), the statistical question; Dr. W. E. Roth (ethnology and anthropology), on the games, sports and amusements of the North Queensland aboriginals; Sir T. Fitzgerald (sanitary science and hygiene), the nature of diseases; Prof. A. Wall (mental science and education), poetry as a factor in education; Mr. P. Oakden (architecture and engineering), no title announced. Many papers were read in each of the sections, and from the titles in the official programme we judge that a large proportion was of wide scientific interest. The handbook prepared for the use of the members contains a short historical sketch of Tasmania, and essays on the natural history of the country. These signs of scientific activity at the antipodes are of interest to those who regard contributions to natural knowledge as essential to the development of national character and progress.

PROF. W. R. DUNSTAN, F.R.S., director of the scientific department of the Imperial Institute, presided on March 4 at the first of a series of six lectures and demonstrations which are being given at the Institute by Mr. R. Hedger Wallace, formerly of the Victorian Agricultural Department, on "The Commercial Products and Agricultural Resources of the Crown Colonies." In his introductory remarks, the chairman explained the object of the course. The Imperial Institute contains magnificent collections of products, illustrative of the natural resources of the colonies, and it is hoped that by lectures and demonstrations such as these the interest and utility of the collections to the general public will be much increased. Following each lecture, Mr. Wallace will give a demonstration in the particular court containing the products of the colony described. A large and increasing number of schools throughout the United Kingdom have applied to the Imperial Institute for small collections of various colonial products, and it is therefore hoped that this course will attract both teachers and pupils. Mr. Wallace began by directing attention to the fact that the value of the imports and exports of Great Britain last year was 522,000,000*l*. and 280,000,000*l*. respectively. It is a matter of importance, therefore, to ascertain whether this adverse balance of 242,000,000*l*. passes to the British planter and manufacturer, and remains within the Empire, or goes to foreign countries. Hence also the desirability of ascertaining what can most profitably be grown in our various colonies. From this point of view England has much to learn from Germany. That country has recently sent out scientific experts to report on the natural resources of its colonies and to ascertain by practical experiment how capital can be most profitably invested. In England, on the other hand, this matter is left largely to private enterprise.

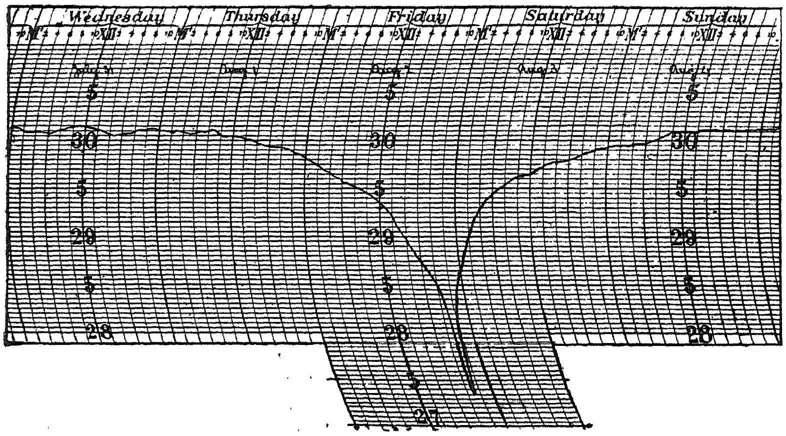
THE influence of mountains on the fall of hail has frequently been the subject of controversy, but up to the present time no certain conclusion appears to have been arrived at. The Italian Meteorological Office has recently published an interesting note upon the question by Prof. V. Monti. The positions chosen were perhaps the most suitable for the purpose of any among the Italian network of stations, viz. the Collegio Romano and Montecavo, an isolated station near Rome, situated at an altitude of about 1000 metres; the complete observations at both stations, for the years 1880–87, are contained in the *Annals* of the Italian Meteorological Office. During this period, forty-one days of hail were recorded at Rome against eighty at Montecavo; the monthly values show two maxima, in April and October, and two minima, in July and December, as regards the excess of days of hail at the mountain station. A comparison of days of thunderstorm shows, on the other hand, that there were 176 such storms at Rome, against 129 at Montecavo. This seems to show that the excess of hail at the mountain station is not attributable to a greater intensity of atmospheric electricity. The author gives a table showing that the monthly mean temperature at Rome is at times about 10° higher than at Montecavo, and suggests that the fusion of the hail in traversing a warmer stratum of air may to some extent account for the smaller amount at the lower station.

PROF. TINE TAMMES describes in the *Zeitschrift für wissenschaftliche Mikroskopie*, xviii. p. 280, a convenient form of electrical lamp for use with the microscope, which has been introduced into the Botanical Laboratory at Groningen. The lamp itself is an incandescent lamp of about 4 cm. diameter, and is enclosed in an iron box the weight of which adds to its steadiness. This box is open at the front and back, the back opening letting out the heat while the front opening is furnished with grooves for inserting glass plates. The front plate is of ground glass, specially chosen for its low absorbing power and absence of coarse grain, and this gives a uniformly bright area as source of illumination. Behind this is a screen of cobalt or other coloured glass for absorbing the superfluous yellow rays.

A PAPER on the metallography or photomicrography of iron and steel is communicated to the *Journal* of the Royal Microscopical Society for February by Mr. William H. Merrett.

The subject is one of recent development, and among other workers the names of Dr. Sorby, Profs. Marten and Wedding, and M. Osmond, of Paris, are mentioned. The paper deals with the analogy between the transformations occurring in steel and in frozen saline solutions, taking as illustrations Sir W. C. Roberts-Austen's diagrams of equilibrium curves. The methods of preparing and polishing steel for opaque examination are described, including Prof. Le Chatelier's method of obtaining sufficiently fine polishing powders. The paper is illustrated by several photographs of the different constituents of iron and steel under a magnification of 850 diameters. Although metallography was originally of scientific interest only, it has now become of the greatest commercial importance.

A VERY remarkable barograph trace obtained during a typhoon on August 2-3, 1901, is given in the *Quarterly Journal* of the Royal Meteorological Society (January), and is here reproduced



Barograph trace during typhoon, August 2–3, 1901.

with the permission of the Society. The barograph was on the steamer *Laisang*, which encountered the typhoon somewhere to the northward of the Formosa Channel, in about lat. 25° N., long. 122° E. or thereabouts. The fall and rise of the barometer were most rapid, the range being no less than two inches in eight hours. The chart shows the minimum reading to have been as low as 27·35 in. at 9 p.m. on August 2. Such a low barometer reading is said in the note from which these particulars are derived to have been rarely recorded. It was, however, exceeded on the following occasions:—27·33 in., February 5, 1870, on board H.M.S. *Tarifa*, 500 miles west of Ireland. 27·332 in., January 26, 1884, Ochtertyre, near Crieff, Scotland (*Quarterly Journal* Royal Meteorological Society, vol. x. p. 114). 27·135 in., September 22, 1885, False Point, Orissa, India (NATURE, vol. xxxv. p. 344). 27·38 in., December 8, 1886, Belfast; probably about 27·28 in. over the north of Ireland (*Quarterly Journal* Royal Meteorological Society, vol. xiii. p. 211).

IN the *Irish Naturalist* for March, Dr. R. F. Scharff records the stranding in Dublin Bay of a specimen of the white-beaked dolphin (*Lagenorhynchus albirostris*). The specimen, which is a male, seems of unusually large size, measuring 12 feet in length, the species being stated in text-books not to exceed 9 feet.

STUDENTS of "distribution" will be interested in a paper by Dr. D. Sharp on Oriental beetles which appears in the March number of the *Entomologists' Monthly Magazine*. The author states that in the group Limnichini—the members of which are remarkable for their death-feigning instinct—he finds a remarkable similarity between the Central American and Oriental forms, amounting in one instance to generic identity.

WE have received the second number of the *Nature-Study Journal*, published by the South-Eastern Agricultural College, Wye, Kent. It contains a description of a country walk through a fossiliferous district in autumn, in which attention is directed to the objects of natural history met with, and also samples of "nature-lessons" for children. The editor asks for outlines of a series of lessons suitable for the same purpose.

IN their eleventh annual report, the Society for the Protection of Birds record an increase in the number of their associates, although they have to deplore a falling-off in subscriptions. With the aid of the Royal Society for the Prevention of Cruelty to Animals, the Society has succeeded in obtaining several convictions during the past year, one of the most satisfactory being in the case of a gamekeeper charged with shooting two of the bustards introduced by Lord Walsingham into Norfolk. Some—although not a great—effect appears to have been made upon the plume-trade by the efforts of the Society; but the recent fashion for the skins of entire terns and the wings of gulls as decorations for ladies' hats is a cause for much regret. So great is the demand for these objects that in Yorkshire alone a single dealer is stated to have contracted to supply 10,000 skins to a London firm. The subject of the Society's second essay competition was "the best means of introducing Bird and Arbor Day into England"; and now that the prizes have been awarded, the Society is hopeful that Coronation year may mark the institution of such a day in all the schools of the country.

THE accompanying diffraction effect is reproduced from a plate contributed by Prof. W. S. Franklin to the January number of the *Physical Review*, and represents one of a number of photographs of shadows cast upon a photo-

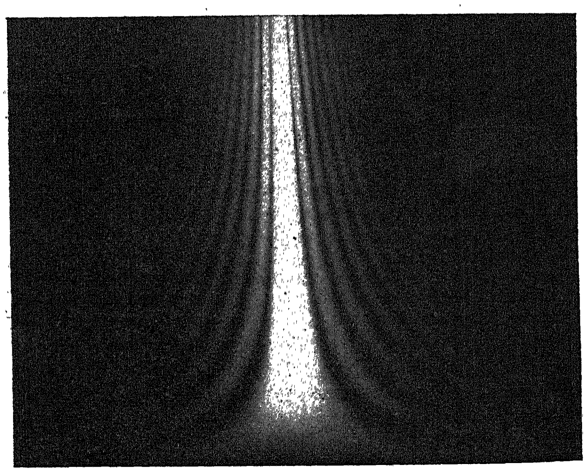


FIG. 1.—Diffraction Shadows of a Tapering Slit.

graphic plate from a monochromatic point of light distant about sixteen metres from the plate. The objects casting the shadows were about three metres from the plate, which was in each case at right angles to the incident light. The

photograph here reproduced shows the shadow of a slit between very carefully worked edges of brass. The slit was about fifteen centimetres in length, tapering from a width of 0·05 centimetre at one end to nearly zero at the other.

IN a recent issue of the *Actes* of the Scientific Society of Chili (vol. xi. part 3), Señor F. Albert publishes an account of the different species of seals frequenting the coasts of that country, together with a summary of the legislation for their protection. It is satisfactory to learn that the Government are fully alive to the necessity for such protection and are doing all they can to see that the various enactments are duly carried out. The regulations forbid any but Chilian subjects to shoot seals or otters at all, while they establish a close time lasting from the beginning of November till the end of February.

TO shake about 200,000 peach trees and 50,000 plum trees for the purpose of dislodging injurious insects is a formidable task, yet it was successfully accomplished several times between April 18 and June 1, 1901, by the Hale Georgia Orchard Company at Fort Valley, Georgia, U.S.A. The insect against which this action was taken was the curculio beetle. The San Jose scale, so prevalent in south Georgia, is thoroughly controlled by the kerosene-water treatment, the beach-tree borer is held in abeyance by the cutting-out method, and the brown rot is fairly well controlled by the Bordeaux treatment, but the curculio baffles all contrivances for its destruction except the

Gang at work catching beetles shaken off fruit trees in Georgia.

tedious method of shaking the trees on which they occur and catching the beetles as they fall. The accompanying illustration from a paper by Messrs. W. M. Scott and W. F. Fiske, in the *Proceedings* of the thirteenth annual meeting of the Association of Economic Entomologists, shows a gang at work catching beetles on sheets stretched upon frames, as they are shaken off the trees. With eleven pairs of sheets, about 40,000 trees were treated in the course of a day. About 137,000 of the beetles were caught and killed during the season, and as a large proportion must have been females capable of depositing eggs, an immense amount of damage was prevented by the work.

TO Mr. O. Voges, of Buenos Ayres, is due the credit of having discovered the smallest bacillus which has yet been identified. It is much smaller than the influenza bacillus, and is only just discernible when magnified about 1500 times. These very minute rods were obtained from abscesses which cattle suffer from in South America, producing a disease known as manquea amongst other names. It is usually found in quite young cattle, and is easily recognisable by the characteristic lameness of one leg which it produces. The bacillus is an anærobe, and produces in artificial cultures the same highly offensive odour which is associated with it in the abscess. Mice, rats and rabbits are quite immune to its action, but guinea-pigs succumb in from 24–48 hours, and the bacilli are found in the heart's blood and all internal organs. Inasmuch as the action of such well-known anærobic pathogenic bacteria as those of tetanus and symptomatic anthrax is due to their toxic products, filtrates of liquid cultures of this bacillus were tested for their toxicity, but even guinea-pigs did not react to such injections, and therefore Voges concludes that the pathogenic action is due to the bacilli themselves and not to their products. An interesting fact noted by Voges is that the animals he inoculated only succumbed when the weather was hot; not once in the winter could he successfully infect one animal. This is also true of the disease in its ordinary course, as the hotter the climate the more fatal are the results. If the abscess is opened in its early stages the disease is arrested and the animal recovers. This simple remedy is recommended by Voges.

THE fourth and concluding number of the second volume of the *West Indian Bulletin* contains several interesting articles. One on the Jamaica fruit trade is a reprint of an account given by a special correspondent in the *Times*, and deals mainly with the successful inauguration of the shipping of bananas to England last year. Mr. A. R. Gilzean contributes a sketch of the history of rice-growing in British Guiana. As a very large proportion of the population of the country is composed of East Indian coolies well acquainted with rice cultivation, there can be no doubt that in time rice will become an important article of commerce, the local conditions being described as ideal. An account is given of recent experiments with sweet potatoes, the cultivation of different varieties in various islands, methods of storage, preparation of meal, &c. Sweet potatoes form a staple food in the islands, and the Imperial Department of Agriculture is endeavouring to induce English people to cultivate a taste for the vegetable by sending fortnightly supplies to London, printed information being given to purchasers as to fifteen different ways of preparing for table. Mr. Maxwell-Lefroy has a lengthy article on suggestions for insect control in the West Indies. He proposes five principal ways of attacking the problems—measures to prevent the introduction of new diseases (such as quarantine or the regulation of plant importation); the adoption of preventive measures; also of remedial measures; the encouragement of useful native birds and other organisms; and the introduction of new insectivorous birds, insects, &c., and the regulation of the importation of new animals. Other papers relate to bee-keeping, "thrips" and "witch-broom" diseases on cacao, methods for destroying land crabs, treatment of imported plants at Jamaica, citrate of lime and concentrated lime juice, &c. The number includes the index to the volume.

THERE are several indications in various islands of the Indo-Pacific region that the fact of being tattooed is thought to be beneficial when the soul passes into the next world. The last example of this belief is an account in *Globus* (Bd. lxxxi. p. 46), by Prof. G. Thilenius, of the tattooing of women in the Laughlan Islands, or Nada, a small group of islands east of the southern end of New Guinea. A considerable surface of the women is tattooed with angled designs, but concentric circles are tattooed on the legs. The belief is that between the Laughlan Islands and the island of Vatum in the Trobriand group, to which their souls should go, there is a great snake over which they must pass. The snake asks each soul for her tattooing. The soul takes off her tattooing and gives it to the snake, who covers itself with it. The snake then becomes broad and flat and the soul passes over, as on a bridge. If the soul is not tattooed the snake shrinks, becomes very narrow, and the soul falls into the sea and cannot reach Vatum. These wretched souls become fish.

PROF. A. TARENETSKY, in an elaborate work, "Beiträge zur Skelet und Schaedelkunde der Aleuten, Konaegen, Kenai

und Koljuschen, mit vergleichend anthropologischen Bemerkungen," published by the Russian Academy of Sciences, has come to very interesting conclusions concerning the still problematic origin of these hyperboreans. His researches are based upon thirty-five skulls and two complete Aleutian skeletons of the museum of the Academy, skulls of other East Asian natives, borrowed from the Medical Academy Museum, having been used for comparison. The conclusions of the author are as follows:—The Aleute skulls represent a strongly pronounced type and offer few traces of mixture with other tribes; notwithstanding some secondary differences, the skulls of both the western and the eastern Aleutes are similar to each other. As to the Konyag skulls, although they mostly are artificially deformed, they are nevertheless very similar to those of the American Indians on the one side and to those of the Aleutes on the other side. They also sharply differ from the skulls of both the western and the eastern Eskimos. Between the Kenais and the Koloshes there is no difference as regards their skulls, which are very near to the skulls of the Aleutes and the Konyags, representing the same type, which is only slightly altered with the Konyags by artificial deformation and by admixture of foreign blood. Consequently, the author makes the supposition that all the four stems have a common origin and are descendants of an Indian stem which belonged, not to the Eskimos, but to the American Red Indians. As to the skeletons of the Aleutes, they are very typical, especially on account of the structure of the very long extremities, and these peculiarities are not known in skeletons of other tribes. Only a few bones, unearthed a couple of years ago in Mongolia and belonging to some probably Turkish stem, offered some likeness with the Aleute skeletons. This find induces the author to believe that the populations of north-west America and Asia may have had a common origin, as they communicated across the Bering Strait. Only part of the Aleute and Konyag skulls had been described by Baer, the remainder being now described for the first time.

DR. T. K. ROSE's treatise on "The Metallurgy of Gold," the fourth edition of which has just been published by Messrs. C. Griffin and Co., provides students of metallurgy and managers of gold mines and smelting works with a concise and valuable statement of the existing conditions of the industry in which they are interested. As an Associate of the Royal School of Mines, Dr. Rose has been able to obtain particulars of practical developments of the metallurgy of gold in many parts of the world. His book has been revised and extended in order to keep it in touch with recent progress, and the changes will enable it to retain its position as a standard work on the subject with which it deals.

THE Hampstead Scientific Society appears to be in a flourishing condition, judging from the Report for 1901, just received. Among the subjects of lectures delivered before the Society during the session covered by the report are curious fish, lodestone lore, a glimpse at the work of Lord Kelvin, the amœba and its allies, the form of the earth, and the human eye. There is an astronomical section; and, as the Society possesses a telescope, observations can be made of celestial objects discussed at the class meetings. The natural history section has in preparation an account of the fauna and flora of Hampstead and its neighbourhood, which it is hoped will be sufficiently advanced for the first part to appear in the autumn of this year. The report points out that a natural history museum would greatly add to the scientific welfare of Hampstead; so that support should be given to the Hampstead Borough Council's scheme for a public museum and art gallery.

SOME time since, MM. Sabatier and Senderens discovered that metallic nickel, reduced from its oxide at as low a temperature as possible, possessed extraordinary catalytic power with regard to the addition of hydrogen, and from time to time they have published numerous syntheses carried out in this way. In the current number of the *Comptes rendus* is given an extremely elegant synthesis of methane based upon the same reaction. It was found that if either carbon monoxide or dioxide mixed with a slight excess of hydrogen is passed over reduced nickel at temperatures between 250° and 300° C., the oxide is reduced and methane is quantitatively produced. In spite of the fundamental importance of the synthesis of methane in organic chemistry, none of the syntheses realised up to the present are of sufficient simplicity and directness to be realised on the lecture table. The new method allows of the preparation of methane from its elements in two steps only, and will doubtless take its place as a standard lecture experiment.

THE additions to the Zoological Society's Gardens during the past week include two Martinican Doves (*Zenaida aurita*), a White-winged Zenaida Dove (*Melopelia leucoptera*) from the West Indies, presented by Mr. D. Seth Smith; a Black-backed Piping Crow (*Gymnorhina tibicen*) from Australia, presented by Mrs. J. Rose; three Derbian Zonures (*Zonurus giganteus*) from South Africa, presented by Captain H. M. Tristram, 12th Lancers; a Slow Loris (*Nycticebus tardigradus*) from Borneo, four Derbian Zonures (*Zonurus giganteus*) from South Africa, six Dark-green Snakes (*Zamenis gemonensis*) European, deposited; a Panda (*Ælurus fulgens*) from Nepal, a Green Bittern (*Butorides virescens*) from America, purchased.

OUR ASTRONOMICAL COLUMN.

NEW ANNUAL TERM IN THE VARIATION OF LATITUDE.—In the *Astronomical Journal*, vol. xxii. pp. 107-108, Prof. H. Kimura announces that from a detailed examination of the observations taken for variation of latitude he has detected a periodicity in the residuals obtained, which appears to indicate the existence of a hitherto unrecognised annual component. Most of the observations were collected in Prof. Albrecht's report in the *Astronomische Nachrichten*, No. 3734. The maximum amplitude of the new term is about 0″·03. At present it is impossible to examine the dependence of this element on geographical position, as the materials have been combined from all stations between $\phi=60°$ N. and $\phi=21°$ N., and the term as found would correspond to a mean latitude 42° N. A future series of observations in different parallels will possibly settle if the new component is a function of the latitude. From the variation curve it appears that the new term has zero values at 0·33 and 0·85, maximum at 0·0 and minimum at 0·57; a noticeable feature of this is that the zeroes lie near the equinoxes, the maxima and minima near the solstices.

OBSERVATIONS OF JUPITER.

JUPITER is now conspicuously visible as a morning star. During the ensuing spring and summer, observers of this planet will have some interesting features to reexamine, though his position, about 19 degrees south of the equator, cannot be regarded as favouring telescopic study. At the time of opposition on August 5 next he will, however, be placed 5 degrees further north than last year, and this will make a sufficient difference in his altitude to improve markedly the general definition of the markings. During the seven months from May to November, 1901, the writer, with a 10-inch reflecting telescope, secured observations of Jupiter on 76 nights, but the image was usually very indistinct and unsteady, and it was only on two or three occasions that the disc was sufficiently sharp to present the more delicate features satisfactorily.

This planet is always interesting from the large number and frequently conspicuous character of the details shown on his surface. These details consist of spots or patches of various tints, forms and sizes situated either on the dusky belts or on the alternating bright zones. The proper motions which affect these markings and displace their relative positions from day to day furnish a mass of material for prolonged study, while the oft-recurring and sometimes rapid changes taking place in their visible aspect provide an attractive field for the draughtsman.

During the present year, observational research in reference to this object is likely to prove of an unusually interesting character, as there are several features which deserve (and will doubtless receive) special attention. During 1901, the red spot exhibited a singular acceleration of motion when compared with its rate in previous years, for it maintained a longitude of 45°, consistently with a rotation period of 9h. 55m. 40s.·6, upon which system II. of Mr. Crommelin's ephemerides is based. It will therefore be most important to trace the position of the spot in ensuing months, as it seems probable that this curiously durable marking, after a constantly increasing retardation between about 1878 and 1900 which augmented its rotation period from 9h. 55m. 34s.·5 to 9h. 55m. 41s.·8, will now travel with greater celerity and give a period becoming shorter with the time until the minimum is reached. If these oscillations in velocity are developed at regular intervals, it will soon be possible to determine the length of the cycle for observations of the red spot or of the hollow in the great southern belt date from 1831. There is some significant evidence in support of the conjecture that the motion of certain markings as well as the apparition of particular spots in various latitudes are recurrent on the planet, and some of the reappearances appear to take place at periods not differing materially from the time of Jupiter's revolution round the sun. The red spot may be looked for near mid-transit on March 13 at 18h. 7m., on March 25 at 18h. 4m., on March 30 at 17h. 13m., on April 6 at 18h. 0m., and on April 11 at 17h. 9m.

Observers should now endeavour to redetect the rapidly moving dark spots which appeared in the north temperate belt of Jupiter in 1880 and 1891. There were a number of spots visible in this latitude in 1901, but the writer found their mean rate of rotation 9h. 55m. 50s. This is nearly 8 minutes in excess of the rotation period found for certain irregular markings in approximately the same latitude in the autumn of 1880 which gave a rate of 9h. 48m. It is a very singular circumstance that in a similar latitude of Jupiter spots are developed showing respectively the shortest and longest rotation periods of any which have ever been observed.

In 1901, a large dark spot was often seen in the south or tropical[1] zone of the planet, and this may prove a repetition of the object observed in the same latitude in 1889–91. This spot exhibits a rotation period of 9h. 55m. 18s.·5, and its more rapid movement will enable it to overtake the red spot in about June, 1902, should both the markings remain visible until that month. The longitude of the south temperate or tropical spot will be as follows during the next three months, and it will follow the red spot at the time-intervals stated if the latter object retains the same longitude (=45°) as in 1901 :—

1902	Longitude	Follows Red spot. h.	m.
March 17	110·5	1	48
April 17	94·1	1	21
May 17	77·7	0	54

The writer obtained an observation of this marking on February 27, when it appeared to be central at 18h. 40m., which would make its longitude 123°·8, but it was very imperfectly seen. The instrument used was a 4-inch Cooke refractor, power 175.

Another important feature for reobservation in 1902 will be the white and dark spots plentifully grouped along the equatorial region of the planet. In the three years 1898, 1899 and 1900, the rotation period of the equatorial current differed very little, the mean value from a large number of spots being 9h. 50m. 24s., or 5m. 17s.·7 less than the rate of the red spot. But in 1901 the mean rotation period of 28 equatorial spots observed at Bristol was 9h. 50m. 29s., or 5m. 12s. less than that of the red spot.

When further observations of these variations have been pursued during many oppositions, the outcome may be both interesting and important as affording a good clue to the physical condition and phenomena of the planet. That great atmospheric changes are in progress on the disc is evident, and it is the facility with which they may be observed and compared which renders this object a singularly attractive one to the possessors of telescopes.

W. F. DENNING.

[1] This interesting marking exhibited a motion coinciding with that of objects placed in the planet's south temperate zone, though its position encroached on the south tropical as well as the south temperate region.

MAGIC SQUARES AND OTHER PROBLEMS UPON A CHESS-BOARD.[1]

THE construction of magic squares is an amusement of great antiquity; we hear of them being constructed in India and in China before the Christian era, whilst they appear to have been introduced into Europe by Moschopulus, who flourished at Constantinople early in the fifteenth century. On the diagram you see a simple example of a magic square, one celebrated as being drawn by Albert Dürer in his picture of "Melancholy," painted about the year 1500 (Fig. 1). It is one of the fourth order, involving 16 compartments or cells. In describing such squares, the horizontal lines of cells are called "rows," the vertical lines "columns," and the oblique lines going from corner to corner

1	15	14	4
12	6	7	9
8	10	11	5
13	3	2	16

FIG. 1.

"diagonals." In the 16 compartments are placed the first 16 numbers, 1, 2, 3, . . . 16, and the magic property consists in this, that the numbers are placed in such wise that the sum of the numbers in every row, column and diagonal is the same, viz., in this case, 34.

It is probable that magic squares were so called because the properties they possessed seemed to be extraordinary and wonderful; they were, indeed, regarded with superstitious reverence and employed as talismans. Cornelius Agrippa constructed magic squares of orders 3, 4, 5, 6, 7, 8, 9, and associated them with the seven heavenly bodies, Saturn, Jupiter, Mars, the Sun, Venus, Mercury and the Moon. A magic square engraved on a silver plate was regarded as a charm against the plague, and to this day such charms are worn in the east.

However, what was at first merely a practice of magicians and talisman makers has now for a long time become a serious

17	24	1	8	15
23	5	7	14	16
4	6	13	20	22
10	12	19	21	3
11	18	25	2	9

FIG. 2.

study for mathematicians. Not that they have imagined that it would lead them to anything of solid advantage, but because the theory of such squares was seen to be fraught with difficulty, and it was considered possible that some new properties of numbers might be discovered which mathematicians could turn to account. This has, in fact, proved to be the case; for from a certain point of view the subject has been found to be algebraical rather than arithmetical, and to be intimately connected with great departments of science, such as the "infinitesimal calculus," "the calculus of operations" and the "theory of groups."

In the next diagram (Fig. 2) I show you a magic square of order 5, the sum of the numbers in each row, column and

[1] A discourse delivered at the Royal Institution on Friday evening, February 14, by Major P. A. MacMahon, F.R.S.

diagonal being 65. This number 65 is obtained by multiplying 25, the number of cells, by the next higher number, 26, and then dividing by twice the order of the square, viz., 10. A similar rule applies in the case of a magic square of any order. The formation of these squares has a fascination for many persons, and, as a consequence, a large amount of ingenuity has been expended in forming particular examples and in discovering general principles of formation. As an example of the amount of labour that some have expended on this matter, it may be mentioned that in 1693 Frénicle, a Frenchman, published a work of more than 500 pages upon magic squares. In this work he showed that 880 magic squares of the fourth order could be constructed, and in an appendix he gave the actual diagrams of the whole of them. The number of magic squares of the order 5 has not been exactly determined, but it has been shown that the number certainly exceeds 60,000.

As a consequence it is not very difficult to compose particular specimens, and, for the most part, the fascinated individuals, to whom I have alluded, have devoted their energies to the discovery of principles of formation. Of such principles I will give a few, remarking that the cases of squares of uneven order 1, 3, 5 . . . are more simple than those of even order 4, 6, . . . and that no magic square of order 2 exists at all. The simplest of all methods for an uneven order is shown in the diagram (Fig. 3), where certain additional cells are added to the square, the numbers written as shown in natural order diagonally, and then the numbers which are outside the square

				5				
			4		10			
		3	16	9	22	15		
	2	20	8	21	14	2	20	
1		7	25	13	1	19		25
	6	24	12	5	18	6	24	
		11	4	17	10	23		
			16		22			
				21				

FIG. 3.

projected into the empty compartments according to an easily understood law. The second method is associated with the name of De la Loubère, though it is stated that he learnt it during a visit to Siam in 1687. The number 1 (see Fig. 2) is placed in the middle cell of the top row, and the successive numbers placed in their natural order in a diagonal line sloping upwards to the right subject to the laws:—

(1) When the top row is reached, the next number is written at the bottom of the next column.

(2) When the right-hand column is reached, the next number is written on the left of the row above.

(3) When it is impossible to proceed according to the above rules, the number is placed in the cell immediately below the last number written.

If we commence by writing the number 1 in any cell except that above indicated, a square is reached which is magic in regard to rows and columns, but not in regard to diagonals.

Subsequent writers have shown that starting with the left-hand bottom cell and using the move of the knight instead of that of the bishop, the general principle of De la Loubère will also lead to a magic square (Fig. 4). The next method is that of De la Hire, and dates from 1705. Two subsidiary squares are constructed as shown, the one involving five numbers 1, 2, 3, 4, 5, and the other five numbers 0, 5, 10, 15, 20. When these squares are properly formed and a third square constructed by adding together the numbers in corresponding cells, this third square is magic (Fig. 5). Time does not permit me to enter into the exact method of forming the subsidiary squares, and I will merely mention that each of them possesses a particular property, viz., only five different numbers are involved, and all five appear in each column and in each row; in other words, no row and no column contains two numbers of the same kind, but no diagonal property is necessarily involved. Such squares are of a great scientific importance, and have been termed by Euler and subsequent writers "Latin squares," for a reason that will presently appear. From a scientific point of view, the chief interest of all arrangements such as I consider this evening lies, not in their actual formation, but in the enumeration of all possible ways of forming them, and in this respect very little has been hitherto

7	20	3	11	24
13	21	9	17	5
19	2	15	23	6
25	8	16	4	12
1	14	22	10	18

FIG. 4.

achieved by mathematicians. No person living knows in how many ways it is possible to form a magic square of any order exceeding 4. The fact is, that before we can attempt to enumerate magic squares we must see our way to solve problems of a far more simple character. For example, before we can enumerate the squares that can be formed by De la Hire's method we must take a first step by finding out how many Latin squares can be formed of the different orders. For the order 5 the question is, "In how many ways can five different objects be placed in the cells so that each column and each

3	4	1	5	2
2	3	4	1	5
5	2	3	4	1
1	5	2	3	4
4	1	5	2	3

15	0	20	5	10
0	20	5	10	15
20	5	10	15	0
5	10	15	0	20
10	15	0	20	5

18	4	21	10	12
2	23	9	11	20
25	7	13	19	1
6	15	17	3	24
14	16	5	22	8

FIG. 5.

row contains each object?" It may occur to some here this evening that such a discussion might be interesting or curious, but could not possibly be of any scientific value. But such is not the case. A department of mathematics that is universally acknowledged to be of fundamental importance is the "theory of groups." Operations of this theory and those connected with logical and other algebras possess what is termed a "multiplication table," which denotes the laws to which the operations are subject. In Fig. 6 you see such a table of order 6 slightly modified from Burnside's "Treatise on the Theory of Groups"; it is, as you see, a Latin square, and the chief problem that awaits solution is the enumeration of such tables; the

questions are not parallel because *all* Latin squares do not give rise to tables in the theory of groups; but still, we must walk before we can run, and a step in the right direction is the enumeration of *all* Latin squares. When I call to mind that the theory of groups has an important bearing upon many branches of physical science, notably upon dynamics, I consider that I have made good my point.

I now concentrate attention on these Latin squares, and observe that the theory of the enumeration has nothing to do with the particular numbers that occupy the compartments; the only essential is that the numbers shall be different one from another. My attention was first called to the subject of the Latin square by a work of the renowned mathematician Euler, written in 1782, entitled "Recherches sur une nouvelle espèce de Quarrés Magiques." I may say that Euler seems to have been the first to grasp the necessity of considering squares possessing what may be termed a magical property of a far less recondite character than that possessed by the magic squares of the ancients, and, as we shall see presently, he might have gone a

I	A	B	C	D	E
A	B	I	D	E	C
B	I	A	E	C	D
C	E	D	I	B	A
D	C	E	A	I	B
E	D	C	B	A	I

FIG. 6.

step further in the same direction with advantage and have commenced with arrangements of a more simple character than that of the Latin square, with arrangements, in fact, which present no difficulties of enumeration, but which supply the key to the unlocking of the secrets of which we are in search. He commences by remarking that a curious problem had been exercising the wits of many persons. He describes it as follows:—There

$a\alpha$	$a\beta$	$a\gamma$	$a\delta$	$a\epsilon$	$a\theta$
$b\alpha$	$b\beta$	$b\gamma$	$b\delta$	$b\epsilon$	$b\theta$
$c\alpha$	$c\beta$	$c\gamma$	$c\delta$	$c\epsilon$	$c\theta$
$d\alpha$	$d\beta$	$d\gamma$	$d\delta$	$d\epsilon$	$d\theta$
$e\alpha$	$e\beta$	$e\gamma$	$e\delta$	$e\epsilon$	$e\theta$
$f\alpha$	$f\beta$	$f\gamma$	$f\delta$	$f\epsilon$	$f\theta$

FIG. 7.

are 36 officers of six different ranks drawn from six different regiments, and the problem is to arrange them in a square of order 6, one officer in each compartment, in such wise that in each row, as well as in each column, there appears an officer of each rank and also an officer of each regiment. Of a single regiment we have, suppose, a colonel, lieutenant-colonel, major, captain, first lieutenant and second lieutenant, and similarly for five other regiments, so that there are in all 36 officers who must be so placed that in each row and in each column each rank is represented, and also each regiment. Euler denotes the six regiments by the Latin letters a, b, c, d, e, f, and the six ranks by the Greek letters $\alpha, \beta, \gamma, \delta, \epsilon, \theta$, and observes that the character of an officer is determined by a combination of two letters, the one Latin and the other Greek; there are 36 such combinations, and the problem consists in placing these combinations in the 36 compartments in such wise that every row and every column contains the 6 Latin letters and also the 6 Greek letters (Fig. 7). Euler found no solution of this problem in the case of a square of order 6, and since Euler's time no one has succeeded either in finding a solution or in proving that no solution exists. Anyone interested has, therefore, this question before him at the present moment, and I recommend it to any-

$a\alpha$	$b\gamma$	$c\beta$
$b\beta$	$c\alpha$	$a\gamma$
$c\gamma$	$a\beta$	$b\alpha$

FIG. 8.

one present who desires an exercise of his wits and a trial of his patience and ingenuity. It is easy to prove that when the square is of order 2, viz. the case of 4 officers of two different ranks drawn from two different regiments, there is no solution; Euler gave his opinion to the effect that no solution is possible whenever the order of the square is two greater than a multiple of four. In other simple cases he obtained solutions; for example, for the order 3, the problem of 9 officers of three different ranks drawn from three different regiments, it is easy to discover the solution shown in the diagram (Fig. 8), and, as demonstrated by Euler, whenever one solution has been constructed there is a simple process by which a certain number of others can be derived from it. Now if you look at that diagram and suppose the Greek letters obliterated, you will see that the Latin letters are arranged so that each of the letters occurs in each row and in each column, the magical property mentioned above, and for this reason Euler termed such arrangements Latin squares and stated that the first step in the solution of the problem is to enumerate the Latin squares of a given order. As showing the intimate connection between the Græco-Latin square of Euler and ordinary magic squares, it should be noticed that the method of De la Hire, by employing Latin and Greek letters for the elements in his two subsidiary Latin squares, gives rise immediately to the Græco-Latin square of Euler. Euler says in regard to the problem of the Latin square, "The complete enumeration of the Latin squares of a given order is a very important question, but seems to me of extreme difficulty, the more so as all known methods of the doctrine of combinations appear to give us no help," and again, "the enumeration appears to be beyond the bounds of possibility when the order exceeds 5." Moreover, Cayley, in 1890, that is 108 years later, gave a *résumé* of what had been done in the matter, but did not see his way to a solution of the question. Under these circumstances, you will see how futile it is to expect a solution of the magic-square problem when the far simpler question of the Latin square has for so long proved such a tough nut to crack. The problem of the Latin square has eventually been completely solved, and in order to lead you up gradually to an understanding of the method that has proved successful, I ask you to look at the Latin square of order 5 that you see in the diagram (Fig. 9). The first row of letters can be written in any order, but not so the second row, for each column when the second row is written must contain two different

a	b	c	d	e
b	d	e	a	c
c	e	d	b	a
d	c	a	e	b
e	a	b	c	d

FIG. 9.

letters. We must, therefore, be able to solve the comparatively simple question of the number of possible arrangements of the first two rows. For a given order of the letters in the first row, in how many ways can we write the

letters in the second row so that each column contains a pair of different letters? This is a famous question, of which the solution is well known; it is known to mathematicians as the "problème des rencontres." It may be stated in a variety of ways; one of the most interesting is as follows:—A person writes a number of letters and addresses the corresponding envelopes; if he now put the letters at random into the envelopes, what is the probability that not a single letter is in the right envelope?

Passing on to the problem of determining the number of ways of arranging the first three rows so that each column contains three different letters, it may be stated that up to 1898 no solution of it had been given; while it is obvious that as the number of the rows is increased the resulting problems will be of enhanced difficulty. A particular case of the three-row problem had, however, been considered under the title "problème des ménages" and a solution obtained. It may be stated as follows:—

A given number of married ladies take their seats at a round table in given positions; in how many ways can their husbands be seated so that each is between two ladies, but not next to his own wife? For order 5, that is 5 ladies, the question comes to this:—Write down 5 letters and underneath them the same letters shifted one place to the left; in how many ways can the third row be written so that each column contains three different letters? This particular case of the three-row problem for any order presents no real difficulty. The results are that in the cases of 3, 4, 5, 6 . . . married couples there are 1, 2, 13, 80, &c., ways.

Since the year 1890, the problem of the Latin square has been completely solved by an entirely new method, which has also proved successful in solving similar questions of a far more recondite character, and I am here this evening to attempt to give you some notion of the method and some account of the series of problems to which that method has been found to be applicable.

There is, as viewed mathematically, a fundamental difference between arithmetic and algebra; the former may be regarded as an algebra in which the numerical magnitudes under consideration are restricted to be integers; the two branches contemplate discontinuous and continuous magnitude respectively. Similarly, in geometry we have the continuous theory, which contemplates figures generated by points moving from one place to another and in doing so passing over an infinite succession of points, tracing a line in a plane or in space, and also a discontinuous theory, in which the position of a point varies suddenly, *per saltum*, and we are not concerned with any continuously varying motion or position. The present problems are concerned sometimes with this discontinuous geometry and sometimes with an additional discontinuity in regard to numerical magnitude, and the object is to count and not to measure. Far removed as these questions are, apparently, from the subject-matter of a calculus of infinitely small quantities and the variation of quantities by infinitesimal increments, my purpose is to show that they are intimately connected with them and that success is a necessary consequence of the relationship. I must first take you to a much simpler problem than that of the Latin square, to one which in a variety of ways is very easy of solution, but which happens to be perhaps the simplest illustration of the method. In the game of chess a castle can move either horizontally or vertically, and it is easy to place 8 castles on the board so that no piece can be taken by any other piece. One such arrangement is shown in Fig. 10. The condition is simply that one castle must be in each row and also in each column. Every such arrangement is a diagrammatic representation of a certain mathematical process performed upon a certain algebraical function. For consider the process of differentiating x^8; it may be performed as follows:—Write down x^8 as the product of 8 x's,

$$x\ x\ x\ x\ x\ x\ x\ x,$$

and now substitute unity for x in all possible ways and add the results; the substitution can take place in eight different ways, and the addition results in $8x^7$, which will be recognised as the differential coefficient. Observe that the process of differentiation is thus broken up into eight minor processes, each of which may be diagrammatically represented on the first row of the chess-board by a unit placed in the compartment corresponding to the particular x for which unity has been substituted. If we now perform differentiation a second time, we may take the results of the above minor processes and in each of them again substitute unity for x in all possible ways; since in each the substitution can take place in seven different ways, it is seen that we can regard the process of differentiating twice as composed of $8 \times 7 = 56$ minor processes, each of which can be diagrammatically represented by two units, one in each of the first two rows of the chess-board, in positions corresponding to the substitutions of unity for x that have been carried out. Proceeding in this manner in regular order up to the eighth differentiation, we find that the whole process of differentiating x^8 eight times in succession can be decomposed into $8 \times 7 \times 6 \times 5 \times 4 \times 3 \times 2 \times 1 = 40{,}320$ minor processes, each of which is denoted by a diagram which slight reflection shows is a solution of the castle problem (Fig. 11). There are, in fact, no more solutions, and the whole series of 40,320 diagrams

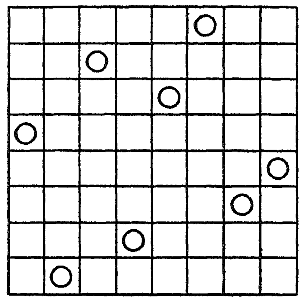


FIG. 10.

constitutes a picture in detail of the differentiations. Simple differentiations of integral powers thus yield the enumerative solutions of the castle problem on chess-boards of any size.

We have here a clue to a method for the investigation of these chess-board problems; it is the grain of mustard seed which has grown up into a tree of vigorous growth, throwing out branches and roots in all sorts of unexpected directions. The above illustrations of differentiation gave birth to the idea that it might be possible to design pairs of mathematical processes and functions which would yield the solution of chess-board problems of a more difficult character. Two plans of operation present themselves. In the first place we may take up a particular question, the Latin square for instance, and attempt to design, on the one hand, a process, and, on the

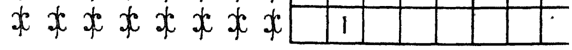


FIG. 11.

other hand, a function the combination of which will lead to the series of diagrams. In the second place, we may have no particular problem in view, but simply start by designing a process and a function, and examine the properties of the series of diagrams to which the combination leads. The first of these plans is the more difficult, but was actually accomplished in the case of the Latin square and some other questions; but the second plan, which is the proper method of investigation, met with great success, and the Latin square was one of its first victims, a solution of a more elegant nature being obtained than that which had resulted from the first plan of operations. There is such an extensive choice of processes and functions that many solutions are obtainable of any particular problem. I will now

give you an idea of a solution of the Latin square, which is not the most elegant that has been found, but which is the most suitable to explain to an audience. Suppose we have five collections of objects, each collection containing the same five different objects, *a*, *b*, *c*, *d*, *e* (Fig. 12). I suppose the objects distributed amongst five different persons in the following manner:—The first person takes one object from each collection, so as to obtain each of the five objects; he can do this in 120 different ways; we will suppose that he takes *a* from the first, *b* from the second, *c* from the third, *d* from the fourth, *e* from the fifth; the collections then become as you see in Fig. 12, second row. Now suppose the second man to advance with the intention of taking one object from each collection and obtaining each of the five objects, he has not the same liberty of choice as had the first, because he cannot take *a* from the first collection or *b* from the second, &c. However, he has a good choice in his selection, and we will suppose him to take *b* from the first collection, *d* from the second, *e* from the third,

$$\begin{array}{ccccc}
(abcde) & (abcde) & (abcde) & (abcde) & (abcde) \\
(.bcde) & (a.cde) & (ab.de) & (abc.e) & (abcd.) \\
(..cde) & (a.c.e) & (ab.d.) & (.bc.e) & (ab.d.) \\
(...de) & (a.c..) & (ab...) & (..c.e) & (.b.d.) \\
(....e) & (a....) & (.b...) & (..c..) & (...d.)
\end{array}$$

FIG. 12.

a from the fourth, *c* from the fifth. The collections then become as you see in the third row. The third man who has the same task finds his choice more restricted, but he elects to take *c* from the first, *e* from the second, *d* from the third, *b* from the fourth and *a* from the fifth. The fourth man finds he can take *d*, *c*, *a*, *e*, *b*, and this leaves *e*, *a*, *b*, *c*, *d* for the last man. If we plot the selections that have been made by the five men, we find the Latin square shown in Fig. 9.

Every division of the objects that can be made on this plan gives rise to a Latin square, and all possible distributions give rise to the whole of the Latin squares. Now it happens that a mathematical process exists (connected with algebraical symmetric functions) that acts towards a function representing the five collections in exactly the same way as I have supposed the men to act, and when the process is performed five times in succession, an integer results which denotes exactly the number of Latin squares of order 5 that can be constructed. Moreover, *en route* the "problème des rencontres" and the problems connected with any definite number of rows of the space are also solved.

I will now mention some questions of a more difficult character that are readily solved by the method. In the

$$\begin{array}{cccc} a & a & b & c \\ a & b & c & a \\ b & c & a & a \\ c & a & a & b \end{array} \qquad \begin{array}{cccc} a & a & b & b \\ a & b & a & b \\ b & b & a & a \\ b & a & b & a \end{array} \qquad \begin{array}{cccc} a & a & a & b \\ a & a & b & a \\ a & b & a & a \\ b & a & a & a \end{array}$$

FIG. 13.

"problème des ménages" you will recollect that the condition was that no man must sit next to his wife. If the condition be that there must be at least four (or any even number) persons between him and his wife, the question is just as easily solved. Latin squares where the letters are not all different in each row and column are easily counted. Illustrations of these are shown in Fig. 13. One of these extended to order 8 gives the solution of the problem of placing 16 castles on a chess-board, 8 black and 8 white, so that no castle can take another of its own colour.

Theoretically, the Græco-Latin squares of Euler can be counted, but I am bound to say that the most laborious calculations are necessary to arrive at a numerical result or even to establish that in certain cases the number sought is zero.

Next consider a square of any size and any number of different letters, each of which must appear in each row and in each column, while there is no restriction as to the number that may appear in any one compartment. In this case the result is very simple; suppose the square of order 4 (Fig. 14), and that there are seven different letters that must appear in each row and column; the number of arrangements is $(4\,!)^7$, viz., 4, the order of the square, must be multiplied by each lower number and the number thus reached multiplied seven times by itself.

Finally, if there be given for each row and for each column a different assemblage of letters and no restriction be placed upon the contents of any compartment, the number of squares in which all these conditions are satisfied can be counted. This, of course, is a far more recondite question than that of the Latin square, and cannot be attacked at all by any other method.

I now pass to certain purely numerical problems. Suppose we have a square lattice of any size and are told that numbers are to be placed in the compartments in such wise that the sums of the numbers in the different rows and columns are to have any given values the same or different. This very general question, hitherto regarded as unassailable, is solved quite easily. The solution is not more difficult when the lattice is rectangular instead of square and when any desired limitation is imposed upon the magnitude of the numbers.

Up to this point, the solutions obtained depend upon processes of the differential calculus. A whole series of other problems, similar in general character, but in one respect essentially different, arises from the processes of the calculus of finite differences. Into these time does not permit me to enter. In the case of magic squares as generally understood, the method brought forward marks a distinct advance in connection with De la Hire's method of formation by means of a pair of Latin squares, but apart from this a great difficulty is involved in the condition

abcd	·	ef	g
e	abc	dg	f
f	deg	ab	c
g	f	c	abde

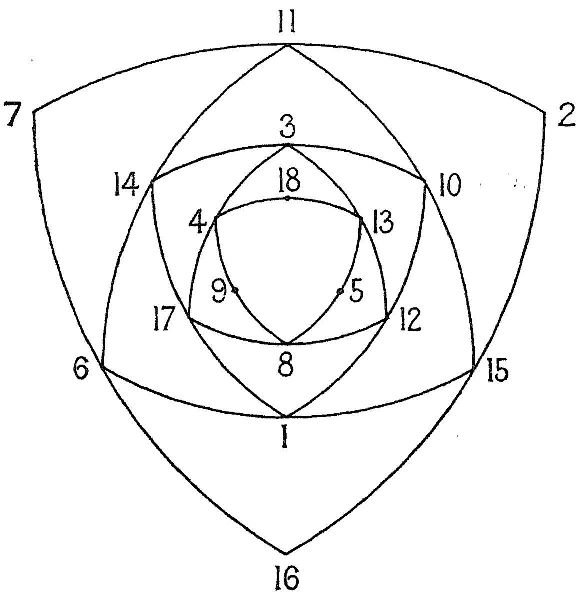
FIG. 14.

that no two numbers must be the same. Still, a statement can be made as to a succession of mathematical processes which result in a number which enumerates the magic squares of a given order. In any cases except those of the first few orders, the processes involve an absolutely prohibitive amount of labour, so that it cannot yet be said that a practical solution of the question has been obtained.

Scientifically speaking, it is the assignment of the processes and not the actual performance of them that is interesting; it is the method involved rather than the results flowing from the method that is attractive; it is the connecting link between two, to all appearance, widely separated departments of mathematics that it has been fascinating to forge and to strengthen. Of all the subjects that for hundreds of years past have from time to time engaged the attention of mathematicians, perhaps the most isolated has been the subject of these chess-board arrangements. This isolation does not, I believe, any longer exist. The whole series of diagrams formed according to any given laws must be regarded as a pictorial representation, in greatest detail, of the manner in which a certain process is performed. We have to exercise our wits to discover what this process is. To say and to establish that problems of the general nature of the magic square are intimately connected with the infinitesimal calculus and the calculus of finite differences is to sum the matter up. Much, however, remains to be done. The present method is not able to deal with diagonal properties, or with arrangements which depend upon the knight's move. The subject is only in its infancy at present. More workers

are required who will, without doubt, introduce new ideas and obtain results far transcending those we are in possession of now. The latest work has shown that the method is applicable to boards of triangular and trapezoidal shapes, and also to solid boards in three dimensions, so that the remote ground occupied by magic and Nasik cubes will soon be invaded.

In conclusion, I bring before you an interesting example of magic arrangement that I found whilst engaged in rummaging amongst the books and documents of the old Mathematical Society of Spitalfields (1717–1845) for the purpose of extracting something which might interest or amuse, if it might not instruct, the audience I addressed in Section A of the British Association for the Advancement of Science at Glasgow last autumn. It is an arrangement of the first eighteen numbers on five connected triangles; the magical property consists in the circumstance that the numbers 19, 38 and 57 appear as sums in a variety of ways. The number 19 appears nine times, 38 twelve times and 57 fourteen times (Fig. 15).



$$
\begin{aligned}
9 &= 7+12=14+5=4+15 \\
&= 6+13=17+2=9+10 \\
&=16+3=1+18=8+11 \\
38 &= 7+11+14+6=11+2+15+10=15+16+6+1 \\
&=11+10+3+14=10+15+1+12=1+6+14+17 \\
&=14+3+4+17=3+10+12+13=12+1+17+8 \\
&=3+13+18+4=13+12+8+5=8+17+4+9 \\
57 &= 7+14+4+5+12+15=6+17+9+13+10+2=16+1+8+18+3+11 \\
&=7+11+2+15+16+6=11+10+15+1+6+14=14+3+10+12+1+17 \\
&=3+13+12+8+17+4=4+18+13+5+8+9 \\
&=9+4+3+10+15+16=18+13+12+1+6+7=5+8+17+14+11+2 \\
&=9+8+12+10+11+7=18+4+17+1+15+2=5+13+3+14+6+16
\end{aligned}
$$

FIG. 15.

I should say that I feel conscious that I have not been able to introduce the subject of my lecture without occasional and, perhaps, in the circumstances, unavoidable obscurity. For the rest, I have felt somewhat doubtful as to the interest I might arouse in these problems, but the managers honoured me by inviting me to display to you some of the chips from a pure mathematician's workshop, and I felt no hesitation in accepting.

FORTHCOMING BOOKS OF SCIENCE.

Mr. Felix Alcan (Paris) promises:—"Les Bases scientifiques de l'Éducation physique," by Démeny; "Les Grands Phénomènes géologiques," by Prof. S. Meunier; "Manuel d'Electrothérapie," by A. Weill; "Traité d'Intubation du Larynx," by Bonain; "Manuel d'Histologie pathologique," tome ii., by MM. Durante, Dominici, &c.

Mr. Edward Arnold gives notice of:—"Elementary Principles in Statistical Mechanics, by Dr. J. W. Gibbs, and "The Elements of Experimental Phonetics," by Dr. E. W. Scripture.

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In the list of Messrs. A. Constable and Co., Ltd., we notice:—"The Prevention of Disease," by Drs. Bing, Einhorn, Fischl, Flatau and others, translated.

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UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

OXFORD.—Prof. Tylor has resigned the office of keeper of the University Museum, which he has held since the death of Prof. Henry Smith in 1883. He will retain his leadership in anthropology. Prof. Tylor's magnificent gifts of totemistic objects to the Museum will remain as tokens of the great interest which he has taken in the welfare of the institution with which his more immediate connection will now cease.

At a meeting of the Junior Scientific Club on Wednesday, March 5, papers were read by Mr. H. D. Davis (Balliol) on snake poisons, and by Mr. J. Phelps (Trinity) on the boiling points of solutions.

CAMBRIDGE.—Mr. T. H. Havelock, of St. John's College, has been elected to the Isaac Newton studentship in physical astronomy. Mr. Havelock and Mr. J. E. Wright (senior wrangler 1900), of Trinity, are the Smith's prizemen of the year.

The Allen studentship is awarded to Mr. F. N. Hales, Trinity, for research in psychophysics.

The Balfour studentship in animal morphology is awarded to Mr. J. S. Budgett, Trinity.

The General Board of Studies propose to re-establish the office of assistant to the superintendent of the Museum of Zoology with a view to the arrangement of the collections.

MR. R. A. S. REDMAYNE has been appointed professor of mining in the University of Birmingham, and Mr. Thomas Turner professor of metallurgy. Mr. Redmayne is resident manager of the Seaton Delaval Collieries in Northumberland, and Mr. Turner has for several years been director of technical instruction to the Staffordshire County Council.

THE sum of 25,000*l.* has been given by Mr. William Johnston, shipowner of Liverpool, for furthering the university movement in that city. The money will be devoted, in accordance with the wishes of the donor, to promote research in pathology and physiology. The 25,000*l.* is divided as follows:—10,000*l.* is allocated to found a chair of chemical biology, 6000*l.* at 5 per cent. interest to endow permanently three research fellowships of 100*l.* a year each. Of these fellowships one is held by a medical graduate of a colonial university, a second by a graduate of medicine of the United States, and a third by a research student in gynæcology. The remaining 9000*l.* is to be spent in building a laboratory adjoining the Thompson Yates laboratories, to accommodate the tropical school, the professor of chemical biology, experimental medicine, comparative pathology, and serum research department.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, February 6.—"The Density and Coefficient of Cubical Expansion of Ice." By J. H. Vincent, D.Sc., B.A., St. John's College, Cambridge. Communicated by Prof. J. J. Thomson, F.R.S.

February 20.—"Note on the Anomalous Dispersion of Sodium Vapour." By W. H. Julius, Professor of Physics in the University of Utrecht. Communicated by C. Vernon Boys, F.R.S.

"On the Physics and Physiology of the Protoplasmic Streaming in Plants." By Alfred J. Ewart, B.Sc. (Oxon), D.Sc. (Lond.), Ph.D., F.L.S., Lecturer on Botany in the Birmingham Technical Institute. Communicated by Francis Gotch, D.Sc., F.R.S.

February 27.—"Note on the Discovery of a New Trypanosoma." By D. Bruce, F.R.S., Lieut.-Colonel., R.A.M.C.

The author received from South Africa specimens of blood taken from cattle which contain a new species of Trypanosoma.

This new species can be at once distinguished from the Trypanosomas of Surra, tse-tse fly disease, or rat by its larger size, it being almost twice as large as any of the others. In general appearance it conforms closely to the others in possessing an oval protoplasmic body, a longitudinal fin-like membrane, and a single flagellum.

This new Trypanosoma was lately discovered by Dr. A. Theiler, who is in charge of the bacteriological laboratory of the Medical Officer of Health, Pretoria, Transvaal.

He states that at first he was under the impression that he had merely hit against the familiar Trypanosama of tse-tse fly disease. He, however, was struck by its larger size, and tried a few inoculation experiments. He found that the new Trypanosoma only infects cattle. Horses, dogs, goats, rabbits and guinea-pigs are all immune, neither showing symptoms nor the presence of the parasites in the blood. With the same blood he infected two calves, which showed distinct febrile reaction, and at the same time the parasites appeared in the blood.

He found the parasite for the first time in the blood of a young ox which had just recovered from an attack of rinderpest, and since then has successfully inoculated calves from two other cattle.

He describes the disease as an acute pernicious anæmia with grave blood changes, a general anæmia without deformation of the elements of the blood, or, lastly, only a slight fever, and that there exists a natural immunity in cattle against this Trypanosoma.

He is of opinion that this disease is the same as that attributed by Dr. Kolle—who studied rinderpest in South Africa with Koch during the last outbreak—to bovine malaria. Dr. Kolle overlooked the Trypanosoma, saw that the disease was infectious, and thought he observed endoglobular parasites and pigment in the red blood corpuscles.

As this discovery seems to be an interesting one, and as

Dr. Theiler deserves great credit for the observation, it is proposed that this Trypanosoma be named after the discoverer *Trypanosoma Theileri.*

Royal Microscopical Society, February 19.—Mr. W. Carruthers, F.R.S., vice-president, in the chair.—The chairman directed attention to an interesting exhibition, by Mr. Conrad Beck, of typical bacteria.—The secretary, in the absence of the author, read a paper by Mr. Nelson on polarising with the microscope, wherein the use of tourmalines was advocated. One tourmaline, of a smoky tint, with the slightest dash of pink, free from veins or specks, and not less than $\frac{1}{4}$-inch in diameter, should be mounted in a cap to fit over the eye-piece. The other tourmaline might be of the ordinary yellow-green variety, but larger, about $\frac{6}{10} \times \frac{6}{10}$ inch, mounted in a metal screen, $2\frac{3}{4} \times 3\frac{1}{2}$ inches, so as to exclude all light not passing through the tourmaline. This screen is to be placed in front of and close to the lamp chimney. Any form of substage condenser can be used with this new arrangement of tourmalines, with the exception of apochromatic condensers, which should not be used in polariscope work because the fluorite used in their construction itself polarises. The images obtained by this new method will be just as critical as those in a microscope where no polariscope is used. The paper concluded with an explanation of the advantages obtained in the adoption of the arrangement in the investigation of phenomena due to the interference of polarised light. Mr. Karop thought it would be a great advantage if a tourmaline prism could be rendered effective, as Nicol's prisms were expensive; he thought, however, that a sufficiently large piece of flawless tourmaline would be as expensive as a Nicol's prism.

PARIS.

Academy of Sciences, March 3.—M. Bouquet de la Grye in the chair.—On an antique vase found at Abou-Roach, by M. Berthelot. Contrary to expectation, this vase proved to be not metallic, but appears to have been prepared by the reaction between a fine sand and a mixture of litharge and common salt. —Researches on the silicide of calcium, by MM. H. Moissan and W. Dilthey. As the accounts of the properties of calcium silicide given by Wöhler, Chalmot and Jacobs are contradictory, the authors undertook its reinvestigation. It is obtained by the reaction of lime and silicon at the temperature of the electric furnace, but since calcium silicide is readily oxidised by fused lime it is necessary to keep the silicon in excess. The silicide obtained in this way contained only silicon as impurity, and in one case this amounted to only 1 per cent. Calcium silicide acts very slowly upon water, the reaction being complete only after some months. Hydrogen is the only gas evolved, no gaseous compound of silicon being produced. Hydrochloric acid attacks it more rapidly, hydrogen again being the only gas produced.—On the crystallisation of iron peroxide, by M. Alfred Ditte. The conversion of oxide of iron into the crystallised form by ignition of sulphate of iron with salt is due to the combined action of the vapours of ferric chloride, hydrochloric acid and sodium chloride. The action takes place still more readily in the presence of fluorides, but in this case the oxide is liable to be contaminated by traces of insoluble fluorine compounds.—On a new Trypanosoma of the Bovidæ, by M. A. Laveran. The new species is classified as *Tr. Theileri*, and is clearly distinguished from *Tr. Brucei* by the fact that the latter is inoculable into a large number of mammals, whilst the new species appears to be special to the Bovidæ. It is pathogenic, producing anæmia either with or without fever. During the course of the fever the parasites may be found in the blood for some weeks. Occasionally there is pernicious anæmia with a rapid destruction of the red corpuscles, leading quickly to a fatal issue.—New syntheses of methane, by MM. Paul Sabatier and J. B. Senderens (see p. 446).—Methane is produced by the action of reduced nickel upon mixtures of hydrogen with carbon monoxide or dioxide.—On the lines of maximum decrease of moduli and algebraic or transcendental equations, by M. Edmond Maillet.—On entire functions and the transcendental meromorphs discovered by M. Painlève, by M. Pierre Boutroux. —The cooling power of air at high pressures and of air in motion, by M. P. Compan. The formula expressing the law of cooling as given by Dulong and Petit has been verified for pressures below atmospheric. The author proposed to see how far this formula was valid when the pressures are higher than atmospheric, when the hot body cools in a chamber of indefinite shape, and when the air is in motion. The constants of Dulong and Petit were found to hold up to pressures of six atmospheres, and were also found to remain unchanged when the cooling took place in the open instead of inside a spherical envelope. The cooling effect of air in motion was found to be represented by the formula $kt\sqrt{u}$, where u is the velocity of translation of the air and t the excess of temperature.—On an electrostatic relay, by M. V. Crémieu. A description of a relay which is capable of automatically regulating the potential of the charge on a condenser.—On the use of the capillary electrometer for measuring the true differences of potential at the contact of amalgams and electrolytes, by M. Lucien Poincaré. A reclamation of priority against M. P. Boley.—On the search for a Hertzian radiation emanating from the sun, by MM. H. Deslandres and Décombe. A discussion as to the best mode of attacking the problem of determining whether any of the Hertzian radiations from the sun reach the lower regions of the earth's atmosphere. The conclusion is drawn that the apparatus for this purpose should be set up in observatories devoted to physical astronomy, side by side with the apparatus for the study of the sun and its atmosphere. A lengthy series of observations will probably be necessary before the question can be finally decided.—The explanation of some celestial phenomena by means of the Hertzian waves, by M. Charles Nordmann. The author draws the conclusion that the sun must emit Hertzian waves, this emission being particularly intense in the regions where violent superficial eruptions are produced and at those times when the intensity of the eruptions is at a maximum, that is to say, in the region of the spots and faculæ and at the moment of maximum solar activity. This view is then applied to the explanation of the form of the solar corona and the spectra of comets. It is claimed for this theory that it is contradicted by no facts, and renders a complete account of many different and otherwise inexplicable phenomena.—On the recombination of the ions in gases, by M. P. Langevin. In a previous note a theory has been given of a method permitting of the direct measurement of the coefficient of recombination of positive and negative ions. The experimental part of the work is given in the present paper. It is shown that the thickness of the gaseous layer and the strength of field may be varied within wide limits without affecting the constancy of this coefficient, which remains between 0·26 and 0·28, a value which coincides with the determination of the same coefficient by Townsend made by an entirely different method. From this it would appear that in air at the ordinary pressure there is about one recombination for every four collisions between ions of opposite signs.—The magnetostriction of nickel steels, by MM. H. Nagaoka and K. Honda.—Remarks on the researches of MM. Nagaoka and Honda, by M. C. E. Guillaume.—On the expansion of steels at high temperatures, by MM. Georges Charpy and Louis Grenet. The coefficients of expansion, which increase with temperature, remain almost exactly equal for the different steels, the percentage of carbon in which varies from 0·03 to 3·5.—The specific heat and atomic weight of vanadium, by MM. C. Matignon and E. Monnet. A crystalline compound of aluminium and vanadium, AlVa, was prepared, and the mean specific heat as determined in this and in a ferro-vanadium was 0·1245, which gives an atomic heat of 6·35 if the atomic weight be taken as 51.—On some thallium combinations, by M. V. Thomas.—On dioxytariric and ketotariric acids, by M. Arnaud.—On the products of condensation of tetramethyldiamidobenzhydrol with some primary aromatic amines in which the para-position is occupied, by MM. A. Guyot and M. Granderye.—New reactions of organometallic derivatives, by M. E. E. Blaise. If the crude product of the reaction of magnesium upon an ethereal solution of an alkyl iodide is treated with ethylene oxide, the splitting of the magnesium compound takes place for the most part in a different manner from the syntheses already published, the main product being ethylene bromhydrin. At the same time, a small quantity of the expected primary alcohol containing two atoms of carbon more than the original alkyl group is also obtained.—The action of sulphides, sulphites and hyposulphites upon nitro-derivatives of azo-colouring matters, by MM. Rosenstiehl and Suais.—Compounds of alcohol with the chlorides of manganese and cobalt, by M. F. Bourion.—Some facts in opposition to the application without reserve of the laws of osmosis to red blood corpuscles, by MM. H. Stassano and F. Billon. It is generally admitted without question, as a consequence of the laws of osmosis, that the volume of a red corpuscle varies inversely with the

concentration of the solution. Observations are given showing that this principle does not completely express the actual phenomena.—Volume in urology, by M. J. Winter.—The employment of the electric arc in iron in phototherapy, by MM. André Broca and Alfred Chatin.—*Pachypodium Rutenbergianum*, a Madagascan textile plant, by M. Henri Jumelle.—On some rocky veins which traverse the dunite ground mass of Koswinsky, by M. L. Duparc.

DIARY OF SOCIETIES.

THURSDAY, MARCH 13.

ROYAL SOCIETY, at 4.30.—Croonian Lecture, on Certain Chemical and Physical Properties of Hæmoglobin: Prof. A. Gamgee, F.R.S.

INSTITUTION OF ELECTRICAL ENGINEERS, at 8.—Adjourned discussion on the following papers:—Electric Shock and Legislation thereon: Major-General C. E. Webber, C.B., R.E.—Electric Shocks: F. B. Aspinall.—Electric Shocks at 500 volts: A. P. Trotter.

MATHEMATICAL SOCIETY, at 5.30.—The Theory of Cauchy's Principal values (III.): Mr. G. H. Hardy.—The Solutions of a System of Linear Congruences: Rev. J. Cullen.—Algebraical Connection between Zonal Harmonics of Orders differing by an Integer: R. Hargreaves.—On Quadrature Formulæ: J. Buchanan.

SOCIETY OF ARTS (Indian Section), at 4.30.—The Indian Famine of 1899, and the Measures taken to meet It: T. W. Holderness.

FRIDAY, MARCH 14.

ROYAL INSTITUTION, at 9.—Magnetism in Transitu: Prof. S. P. Thompson, F.R.S.

ROYAL ASTRONOMICAL SOCIETY, at 5.—Note on the Green Flash: T. W. Backhouse.—The Flash Spectrum, Sumatra Eclipse, 1901: S. A. Mitchell.—Observations of Nova Cygni (1876) made with the 40-inch Refractor of the Yerkes Observatory: E. E. Barnard.—Anomalous Occultations of Stars by the Moon: G. W. Hough.—The Duration of Totality at Naval-moral, 1900: C. T. Whitmell.—Note on Prof. Turner's Recent Paper on Photographic Surveying: H. G. Fourcade.—The Magnitude of η-Argûs, 1900–1902: R. T. A. Innes.—On the Variation of S. Carinæ: A. W. Roberts.—Σ 484 and 485, and two pairs: Rev. T. E. Espin.—Double Star Observations. 1899–1901: W. H. Maw.—New Variable Stars found during the Measurements for the Astrographic Catalogue: Royal Observatory, Greenwich.—Results of Micrometer Measures of Double Stars made with the 28-inch refractor: Royal Observatory, Greenwich.—*Promised papers.*—Mean Areas and Heliographic Latitudes of Sun-spots in the Year 1901: Royal Observatory, Greenwich.—Proper Motion of Nova Persei: Royal Observatory, Greenwich.—On the Images formed by a Parabolic Mirror. First paper:—The Geometrical Theory: H. C. Plummer.

MALACOLOGICAL SOCIETY, at 8.

INSTITUTION OF CIVIL ENGINEERS, at 8.—The Use of Long Steel Wires in Surveying: H. J. Deane.

PHYSICAL SOCIETY, at 5.—The Thermal Expansion of Porcelain: A. E. Tutton, F.R.S.—On the Temperature Variation of the Electrical Resistance of Pure Metals, and Allied Matters: W. Williams.—A Suspected Case of the Electrical Resonance of Minute Metal Particles for Light Waves. A New Type of Absorption: Prof. R. W. Wood.

SATURDAY, MARCH 15.

ROYAL INSTITUTION, at 3.—Some Electrical Developments: Lord Rayleigh, F.R.S.

MONDAY, MARCH 17.

VICTORIA INSTITUTE, at 4.30.—Adaptation and Selection in Nature, and their Bearing on the Evidence of Design: Dr. W. Kidd.

SOCIETY OF ARTS, at 8.—Photography applied to Illustration and Printing: J. D. Geddes.

TUESDAY, MARCH 18.

ROYAL INSTITUTION, at 3.—Recent Researches on Protective Resemblance, Warning Colours and Mimicry in Insects: Prof. E. B. Poulton, F.R.S.

INSTITUTION OF CIVIL ENGINEERS, at 8.—*Paper to be further discussed*:—Electrical Traction on Railways: W. M. Mordey and B. M. Jenkin. Papers will be read:—The Greenwich Footway-Tunnel: W. Copperthwaite.—Subaqueous Tunnelling through the Thames Gravel, Baker Street and Waterloo Railway: A. H. Haigh.

ZOOLOGICAL SOCIETY, at 8.30.—The Evolution of Horns and Antlers: Dr. Hans Gadow, F.R.S.—Notes on the Transformations of some South-African Lepidoptera: Lt.-Col. J. M. Fawcett.—On a new Stridulating-Organ in a Scorpion: R. I. Pocock.

ROYAL STATISTICAL SOCIETY, at 5.

WEDNESDAY, MARCH 19.

CHEMICAL SOCIETY, at 5.30.—The Absorption Spectra of Metallic Nitrates, Part I.: W. N. Hartley.—A Method of Determining the Ratio of Distribution of a Base between Two Acids: H. M. Dawson and F. E. Grant.—On the Molecular Complexity of Acetic Acid in Chloroform Solution: H. M. Dawson.—On the Existence of Polyiodides in Nitrobenzene Solution: H. M. Dawson and R. Gawler.—Nitrogen Chlorides containing the Propionyl Groups: F. D. Chattaway.—Derivatives of a-Aminocamphoroxime: A. Lapworth and A. W. Harvey.—Preparation of Sulphamide from Ammonium Amidosulphite: E. Divers and M. Ogawa.—Hypoiodous Acid: R. L. Taylor.

SOCIETY OF ARTS, at 8.—Electric Traction. London's Tubes, Trams, and Trains: J. C. Robinson.

ROYAL MICROSCOPICAL SOCIETY, at 7.30.—Exhibition of Foraminifera: A. Earland.

ENTOMOLOGICAL SOCIETY, at 8.—Notes on Some Cases of Seasonal Dimorphism in Butterflies; with an Account of Experiments made by Mr. Guy A. K. Marshall: Dr. F. A. Dixey.—Mimicry illustrated by the Sanger Shepherd Three Colour Process: Prof. E. B. Poulton, F.R.S.

ROYAL METEOROLOGICAL SOCIETY, at 7.30.—La Lune mange les Nuages. A Note on the Thermal Relations of Floating Clouds: W. N. Shaw, F.R.S.—The Prevalence of Gales on the Coasts of the British Islands during the Thirty Years 1871–1900: F. J. Brodie.

THURSDAY, MARCH 20.

ROYAL SOCIETY, at 4.30.—*Probable papers*:—Development of the Layers of the Retina in the Chick after the Formation of the Optic Cup: J. Cameron.—On a Peculiarity of the Cerebral Commissures in certain Marsupialia, not hitherto recognised as a Distinctive Feature of the Diprotodontia: Prof. G. Elliot Smith.—The Classification of the Elements: Prof. H. E. Armstrong, F.R.S.—On a Throw-Testing Machine for Reversals of Mean Stress: Prof. Osborne Reynolds, F.R.S., and J. H. Smith.—On the Equilibrium of Rotating Liquid Cylinders: J. H. Jeans.—A Portable Telemeter, or Range-finder: Prof. G. Forbes, F.R.S.

LINNEAN SOCIETY, at 8.—Electric Response in Ordinary Plants under Mechanical Stimulus: Prof. J. C. Bose.—On the Fruit of *Melocarina bambusoides*, Trin., an Exalbuminous Grass: Dr. O. Stapf.—On Malacostraca from the Red Sea Collected by Dr. H. O. Forbes: Messrs. Alfred O. Walker and Andrew Scott.

INSTITUTION OF ELECTRICAL ENGINEERS, at 8.—Problems of Electric Railways: J. Swinburne and W. R. Cooper.

FRIDAY, MARCH 21.

ROYAL INSTITUTION, at 9.—Recent Developments in Colouring Matters. (In English): Prof. Otto N. Witt.

INSTITUTION OF MECHANICAL ENGINEERS, at 8.—Fencing of Steam and Gas-Engines: H. D. Marshall.—Fencing or Guarding Machinery used in Textile Factories: S. R. Platt.—Protection of Lift-shafts, and Safety Devices in connection with Lift-Doors and Controlling Gear: H. C. Walker.—Guarding Machine Tools: W. H. Johnson.

EPIDEMIOLOGICAL SOCIETY, at 8.30.—Infantile Mortality in the Tropics Dr. Daniels.

SATURDAY, MARCH 22.

ROYAL INSTITUTION, at 3.—Some Electrical Developments: Lord Rayleigh, F.R.S.

ESSEX FIELD CLUB (Essex Museum of Natural History, Stratford), at 6.30.—Annual Meeting. The Presidential Address will be delivered by Prof. Meldola, F.R.S., on The Coming of Age of the Essex Field Club, a Record of Local Scientific Work, 1880–1901.

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SUPPLEMENT TO "NATURE."

THE PRESENT JUDGED BY THE FUTURE.

Anticipations of the Reaction of Mechanical and Scientific Progress upon Human Life and Thought. By H. G. Wells. Pp. 318. (London: Chapman and Hall. Ltd., 1902.) Price 7*s.* 6*d.*

THIS is a profoundly interesting and suggestive book by a very remarkable man. Mr. Wells was educated at the Royal College of Science; he has a thorough knowledge of, and considerable training in, the great branches of science—physics, chemistry, astronomy, geology and biology. This course of study operated, in the case of Mr. Wells, upon a mind naturally gifted with an extraordinarily vivid imagination and the aptitude for true literary art. In one of his latest works, "Love and Mr. Lewisham," Mr. Wells has told us the story of the struggle for life of a South Kensington student, and for the first time given the Royal College of Science the dignity of literary recognition. But it is by his audacious and fascinating "imaginings" as to the arrival on our planet of the inhabitants of Mars, the strange evolution and changes in the nature of men and the earth's surface as seen a million years hence, the morphology and habits of the inhabitants of the moon, the nocturnal freezing and solidification of its atmosphere, and as to other such topics that Mr. H. G. Wells is best known. The really wonderful range of knowledge shown in these stories, the scientific accuracy of the abundant details, the absolute restraint of the weird histories recounted, within the limits of what scientific criticism must admit as possible—nay, even probable, given the one initial miracle of anyone having and recording experiences of such things—lend a special charm to Mr. Wells' writings wanting in those of all other masters of this kind of literary craft from Swift to Jules Verne. One of his shorter stories, "The Star"—calmly recording in the words of a survivor the approach and passage of a huge meteor which causes the ocean to sweep the land-surface of the earth in all parts to a depth of two hundred feet—is written with such faithful adherence to scientific possibility and such convincing art in narrative that I, for one, am haunted by the conviction that the thing has occurred in past epochs more than once, and may at any time occur again.

The character which Mr. Wells has thus established for himself will necessarily tend to a misunderstanding of the nature of his work recently published under the title "Anticipations." In this book the author is not seeking to amuse us by far-reaching speculation as to remote possibilities. Under the guise of prophecy as to the future, Mr. Wells criticises the present. He imagines that before a hundred years are out (we must all wish this forecast to be realised) there will gradually come into existence

"a naturally and informally organised, educated class, an unprecedented sort of people, a New Republic dominating the world. . . . a new social Hercules that will strangle the serpents of war and national animosity in his cradle . . . a conscious organisation of intelligent and, quite possibly in some cases, wealthy men."

Mr. Wells hopes great things from the cosmopolitanism and intelligence of this coming power. He tells us what the men of this new group will think on various subjects and do in regard to many things, and thus he makes them the vehicle for conveying his righteous indignation and just contempt for a large part of the present ways and beliefs of mankind. It is impossible to do justice in a brief review to a book which deals with nearly every subject under the sun—from motor-cars and cooperative cookery to the struggle for domination among the nations and the essence of religion. Mr. Wells commences his far-reaching survey with a comparatively comfortable chapter on "Locomotion in the Twentieth Century." Special motor tracks and individual motor-cars will to a large extent replace railways. This leads on to the consideration of the "Diffusion of Great Cities." The country will cease to come into the town; the town will spread into the country in proportion as the facilities for locomotion enable a larger and larger area to be in easy touch with the great centres. Then follow chapters on the domestic economy and the relations of class to class—the natural history or bionomics of the social organism in the past, the present and the immediate future of the twentieth century. "War in the Twentieth Century," "The Conflict of Languages" and "Faith, Morals and Public Policy in the Twentieth Century" are the titles of subsequent chapters.

I shall best enable the reader to judge of the manner in which these subjects are treated, and stimulate, I hope, his desire to read Mr. Wells' book by a few quotations.

"The facies of the social fabric has," he says, "changed and—as I hope to make clear—is still changing in a direction from which, without a total destruction and re-birth of that fabric, there can never be any return. The most striking of the new classes to emerge is certainly the share-holding class, the owners of a sort of property new in the world's history. . . . Share property is property that can be owned at any distance and that yields its revenue without thought or care on the part of its proprietor; it is, indeed, absolutely irresponsible property, a thing that no old world property ever was. . . . The shareholder owns the world *de jure*, by the common recognition of the rights of property; and the incumbency of knowledge, management and toil fall entirely to others. He toils not, neither does he spin; he is mechanically released from the penalty of the Fall, he reaps in a still sinful world all the practical benefits of the millennium—without any of its moral limitations."

Among many other ways and habits which are pointed out for improvement in the nascent century, those of house-builders are criticised at some length. Here is a good sample:—

"I find it incredible that there will not be a sweeping revolution in the methods of building during the next century. The erection of a house-wall, come to think of it, is an astonishingly tedious and complex business, the final result exceedingly unsatisfactory. . . . I fail to see the necessity of (and, accordingly, I resent bitterly) all these coral-reef methods. Better walls than this and less life-wasting ways of making them are surely possible. . . . I can dream at last of much more revolutionary affairs, of a thing running to and fro along a temporary rail, that will squeeze out wall as one squeezes paint from a tube, and form its surface with a pat or two as it sets. Moreover, I do not see at all why the walls of small dwelling-houses should be so solid as they are. There still hangs about us the monumental tradition of the

pyramids. It ought to be possible to build sound, portable and habitable houses of felted wire-netting and weather-proofed paper upon a light framework."

Mr. Wells would improve the British workman.

"The average sanitary plumber of to-day in England," he says, "insists upon his position as a mere labourer as though it were some precious thing; he guards himself from improvement as a virtuous woman guards her honour; he works for specifically limited hours and by the hour with specific limitations in the practice of his trade, on the fairly sound assumption that but for that restriction any fool might do plumbing as well as he; whatever he learns he learns from some other plumber during his apprenticeship years—after which he devotes himself to doing the minimum of work in the maximum of time until his brief excursion into this mysterious universe is over."

He has not much respect for the House of Commons.

"Even the physical conditions under which the House of Commons meets and plays at Government are ridiculously obsolete. Every disputable point is settled by a division; a bell rings, there is shouting and running, the members come blundering into the chamber and sort themselves with much loutish shuffling and shoving into the division lobbies. They are counted, as illiterate farmers count sheep; amidst much fuss and confusion they return to their places and the tellers vociferate the result. The waste of time over these antics is enormous, and they are often repeated many times in an evening."

Our author traces the origin of the modern democracy or democratic quasi-monarchy. He has a wholesome contempt for the mode of Government it has produced and the conduct of affairs by party representatives. Every such Government conducts its affairs, he says,

"as though there were no such thing as special knowledge or practical education. The utmost recognition it affords to the man who has taken the pains to know, and specifically to do, is occasionally to consult him upon specific points and override his councils in its ampler wisdom, or to entrust to him some otherwise impossible duty under circumstances of extreme limitation. The man of special equipment is treated always as if he were some sort of curious performing animal."

Of war, Mr. Wells has much to say which is very important and, indeed, should be read, side by side, with the passionate appeal of a similar tendency recently made by Mr. Rudyard Kipling in his "Islanders."

"War," he tells us, "in the past was a thing of days and heroisms; battles and campaigns rested in the hand of the great commander; he stood out against the sky, picturesquely on horseback, visibly controlling it all. War in the future will be a question of preparation, of long years of foresight and disciplined imagination."

The picture given below is a fine sample of Mr. Wells' style and matter:—

"There will be first of all the coming of the war, the wave of excitement, the belligerent shouting of the unemployed inefficients, the flag-waving, the secret doubts, the eagerness for hopeful news, the impatience of the warning voice. I seem to see, almost as if he were symbolic, the grey old general—the general who learnt his art of war away in the vanished nineteenth century, the altogether too elderly general with his epaulettes and decorations, his uniform that has still its historical value, his spurs and his sword—riding along on his obsolete horse by the side of his doomed column. Above all things he is a gentleman—and the column looks at him lovingly with its countless boys' faces, and the boys' eyes are infinitely trustful, for he has won battles in the old time. They will believe in him to the end. They have been brought up in their schools to believe in him and his class, their mothers have mingled respect for the gentlefolk with the simple doctrines of their faith, their first lesson on entering the army was the salute. The 'smart' helmets His Majesty, or some such unqualified person, chose for them lie hotly on their young brows, and over their shoulders slope their obsolete carelessly-sighted guns. Tramp, tramp, they march, doing what they have been told to do; Religion and the Ratepayer and the Rights of the Parent working through the instrumentality of the Best Club in the world have kept their souls and minds, if not untainted, at least only harmlessly veneered, with the thinnest sham of training or knowledge. Tramp, tramp, they go, boys who will never be men, rejoicing patriotically in the nation that has thus sent them forth, badly armed, badly clothed, badly led to be killed in some avoidable quarrel by men unseen. And beside them, an absolute stranger to them, a stranger even in habits of speech and thought, and at any rate to be shot with them fairly and squarely, marches the subaltern—the son of the school-burking shareholding class—a slightly taller sort of boy, as ill taught as they are in all that concerns the realities of life, ignorant of how to get food, how to get water, how to keep fever down and strength up, ignorant of his practical equality with the men beside him, carefully trained under a clerical headmaster to use a crib, play cricket rather nicely, look all right whatever happens, believe in his gentility and avoid talking 'shop.' . . . So the gentlemanly old general—the polished drover to the shambles—rides, and his doomed column march by, in this vision that haunts my mind. I cannot foresee what such a force will even attempt to do, against modern weapons. Nothing can happen but the needless and most wasteful and pitiful killing of these poor lads, who make up the infantry battalions, the main class of all European armies to-day, whenever they come against a sanely organised army. There is nowhere they can come in, there is nothing they can do. The scattered invisible marksmen with their supporting guns will shatter their masses, pick them off individually, cover their line of retreat and force them into wholesale surrenders. It will be more like herding sheep than actual fighting. Yet the bitterest and cruellest things will have to happen, thousands and thousands of poor boys will be smashed in all sorts of dreadful ways and given over to every conceivable form of avoidable hardship and painful disease, before the obvious fact that war is no longer a business for half-trained lads in uniform, led by parson-bred sixth form boys and men of pleasure and old men, but an exhaustive demand upon very carefully educated adults for the most strenuous best that is in them, will get its practical recognition."

Our author proceeds to emphasise

"the inexorable tendency in things to make a soldier a skilled and educated man and to link him, in sympathy and organisation, with the engineer and the doctor, and all the continually developing mass of scientifically educated men that the advance of science and mechanism is producing."

He is led to think it not improbable that the present military hierarchy will be left in this country as a sort of ornamental court attendants, and that an entirely new and independent army will be raised and organised on sound business principles.

"Already," he says, "recruiting is falling off. . . . Elementary education has at last raised the intelligence of the British lower classes to a point when the prospect of fighting in distant lands under unsuitably educated British officers of means and gentility with a defective War Office equipment and inferior weapons has lost much of its romantic glamour."

As to education, Mr. Wells holds, and very many, like myself, will agree with him, that "it is increasingly evident that to organise and control public education is beyond the power of a democratic Government."

"Schools alone are of no avail, universities are merely dens of the higher cramming. . . . At present, in Great Britain at least, the headmasters entrusted with the education of the bulk of the influential men of the next decades are conspicuously second-rate men, forced and etiolated creatures, scholarship boys manured with annotated editions, and brought up under and protected from all current illumination by the Kale-pot of the Thirty-nine Articles. Many of them are less capable teachers and even less intelligent men than many Board School teachers."

There is need, Mr. Wells declares, of a new type of school and also of a new type of university,

"something other than a happy fastness for those precociously brilliant creatures—creatures whose brilliance is too often the hectic indication of a constitutional unsoundness of mind—who can 'get in' before the portcullis of the nineteenth birthday falls."

The coming men, those whom Mr. Wells calls the New Republic, will do away with

"the half-educated, unskilled pretenders, professing impossible creeds and propounding ridiculous curricula, to whom the unhappy parents of to-day must needs entrust the intelligences of their children. . . . The windy pretences of 'forming character,' supplying moral training and so forth, under which the educationalist of to-day conceals the fact that he is incapable of his proper task of training, developing and equipping the mind, will no longer be made by the teacher. Nor will the teacher be permitted to subordinate his duties to the entirely irrelevant business of his pupils' sports." Hereafter "the school and college will probably give only the keys and apparatus of thought, a necessary language or so, a sound mathematical training, drawing, a wide and reasoned view of philosophy, some good exercises in dialectics, a training in the use of those stores of fact that science has made. So equipped the young man and young woman will go on to the technical school of their chosen profession and to the criticism of contemporary practice for their special efficiency and to the literature of contemporary thought for their general development."

The value of literature and the great question of the exclusive study of Greek and Latin writers are alluded to thus:—

"After all, in spite of the pretentious impostors who trade upon the claim, literature, contemporary literature, is the breath of civilised life, and those who sincerely think and write the salt of the social body. To mumble over the past, to live on the classics, however splendid, is senility.'

Many readers will find the final chapter the most interesting in this uncompromising book, where religion, morals and philosophy are briefly but frankly touched. The men of the New Republic will be, says Mr. Wells, "religious" men, and we gather that he is one, a forerunner so to speak, of those new men. They will find "an effect of purpose in the totality of things." That is the essence of being "religious" and amounts to "belief in God." They will "presume to no possibility of knowledge of the real being of God." They will reject the conception of God as an omniscient mind as being as impossible as that which presents Him as an omnipresent moving body.

"They will regard the whole of being, within themselves and without, as the sufficient revelation of God to their souls." "The same spacious faith that will render the idea of airing their egotisms in God's presence, through prayer, or of any such quite personal intimacy, absurd, will render the idea of an irascible and punitive Deity ridiculous and incredible." "To believe completely in God" (as these men will believe) "is to believe in the final rightness of all being." "If" (and this is said in comment on Huxley's Romanes lecture) "the universe is non-ethical by our present standards, we must reconsider these standards and reconstruct our ethics."

Mr. Wells declares that no more "shattering" book than the "Essay on Population" by Malthus has ever been or ever will be written. Darwinism, as one outcome of it, has destroyed the basis of old-fashioned doctrines. An outline is given of the religion of the men of the New Republic. They will not seek to discover the final object of the struggle among existences; they will have abandoned the search for ultimates. They will seek God's purpose in the sphere of their activities and desire no more. They will find in themselves a desire, a passion almost, to create and organise, to put in order, to get the maximum result from certain possibilities. These men will hold life to be a privilege and a responsibility, "not a sort of night refuge for base spirits out of the void." They will, accordingly, not punish criminals by inflicting pain, but will apply Nature's own method of improving her stock—the method of killing. And equally they will not encourage or applaud or support by charity (as many persons do at present)

"a mean-spirited, under-sized, diseased little man, quite incapable of earning a decent living even for himself, married to some underfed, ignorant, ill-shaped, plain and diseased little woman and guilty of the lives of ten or twelve ugly ailing children." "All Christian States of to-day are, as a matter of fact, engaged in slave-breeding. It is a result that endears religion and purity to the sweating employer, and leads unimaginative bishops, who have never missed a meal in their lives, and who know nothing of the indescribable bitterness of a handicapped entry into this world, to draw a complacent contrast with irreligious France."

It seems to me that this book should have—even for those whom it cannot fail to offend—more than the interest which attaches to clever fault-finding. It is, truly enough, an unsparing indictment of existing government, society, education, religion and morality, but it contains also a confession of faith and is full of a spirit of hope and a belief in future development. It is a truthful statement of the outlook of a man who has grasped thoroughly the teachings of modern science and who still keeps hope alive in his breast. E. RAY LANKESTER.

MOTOR VEHICLES.

Motor Vehicles and Motors. By W. Worby Beaumont. (Westminster: A. Constable and Co., Ltd., 1900.)

IT is difficult within the limits of an ordinary notice to deal adequately with this huge work of 618 quarto pages. Mr. Beaumont has attempted to give a complete history of all the applications of mechanical methods of propulsion to vehicles running on the highway, and has described almost every motor vehicle of importance which has been put on the road during the past seventy-five years.

He first deals with that part of the history of self-propelled carriages which is prior to the date when Daimler, by his introduction of the internal combustion petroleum spirit-worked motor, enabled designers for the first time to dispense with the complication of a steam boiler. The author considers Daimler's invention marked an entirely new departure, and he is undoubtedly justified in holding this opinion, as within a few years after Daimler's engine had been applied to motor cars they developed so rapidly and were so commonly used in France and Germany that even in England, the country *par excellence* of restrictive legislation, Parliament was compelled during the year 1896 by sheer force of public opinion to pass an Act removing some of the absurd provisions which had up to that time prohibited any attempt to use motor vehicles on highways or in our streets.

This early historical portion, which occupies the first forty-eight pages, is useful, as it brings clearly before us the great success obtained by the early engineers, such as Hancock, Gurney and others, fully seventy-five years ago. We are apt to forget that the adaptation of steam power to road vehicles was made so successful by these men that it is beyond doubt that if they had been left unharassed by interested opposition and legislation the methods of traffic which now prevail would have been greatly modified; that is to say, that instead of the railways being, as they are at present, practically the sole routes along which traffic is carried, there is no doubt that if Hancock and those of his time had been allowed to continue their work, the highways of England would have carried their share of the traffic, the factories of England would not have been concentrated as they are, all of them close to lines of railway, and many other modifications wholly beneficial would have taken place affecting the distribution, health and happiness of our industrial population.

Designers of modern vehicles learn much from the history of the early attempts. It is interesting, for instance, to notice from the illustrations of the early boilers used by Gurney, Summers and Ogle how closely they approached to the instantaneous generator or flash boiler, as it is called, which was reintroduced by Serpollet in 1889.

Mr. Beaumont has introduced a few chapters on the general questions affecting locomotion on highways; he gives comparatively short descriptions of modern steam vehicles and electrically driven vehicles, but the bulk of his work is occupied by a carefully written history of the modern motor car driven by the internal combustion engine which has been developed from Daimler's discovery in 1885. This history, which occupies more than half of the book, commences with Daimler's work and goes on to describe the important modifications introduced by him and by the various French engineers, Panhard, Levassor, Peugeot, De Dion, Mors and others and by the Daimler Co. themselves at their works at Cammstadt. He also describes very fully the alternative line of discovery followed up by Benz which also commenced in 1885.

This description of the development of the modern motor car is so complete and so profusely illustrated by reproductions of photographs, as well as by scale drawings and diagrams, that it ought to be of considerable value to everyone interested in this matter, whether they be engineer designers, patent agents, or a general reader attempting to post himself in this interesting matter. But the value of the work as a book of reference on the motor car is greatly diminished by the very confused arrangement of this descriptive history. The author could have either described the whole of the successive developments in their strict chronological order or he could have described in turn each inventor's line of development, giving dates so as to enable us to know to whom we owe the initiative in each successful step. Instead of this he has commenced by describing the work of Daimler in 1885 and the next succeeding years, and from thence jumped to a description of the Daimler motors as manufactured in 1899. He then describes the work of the French engineers, without stating when or how they took up Daimler's work, and then goes back to Benz and treats his discoveries in fair chronological order, so that it is very difficult for the average reader of Mr. Beaumont to learn how much is due to Daimler and how much to Benz.

As we have said above, the work is magnificently illustrated; as a rule the author gives an illustration reproduced from a photograph showing the external appearance of each vehicle described. This is followed in most cases by a sectional drawing showing the general arrangement and by detailed drawings to scale of the important internal organs. Some of the drawings, the credit of which we learn from the preface must be given to Mr. d'Esterre, such as those of the general arrangements, Figs. 99 and 100, which are the sectional and plan views of the Panhard and Levassor Daimler motor carriage of 6 h.-p. racing type, are marvellous examples of correct draughtsmanship, and it is a pity that these drawings are confined to the limits of a quarto page, as they would well bear enlargement to double their present scale.

The author has made some attempt to group together his descriptions of certain important features of the engine, such as the carburettors and cylinder-cooling arrangements. He here also gives us a kind of essay on driving and steering wheel axles, although these are common to all classes of mechanically propelled vehicles. He completes his survey of the motor vehicle driven by the internal combustion engine by several pages of tables of the economic performances of these engines when using petrol as fuel. We are inclined to believe with him that many of the French tests of the power given out by these motors are not trustworthy, as the duration of the tests was quite insufficient to enable one

to judge whether the cylinder-cooling devices, wearing surfaces, and other matters which ought to be proportionate to the power developed, were in these cases sufficient for their purpose. He further points out that none of the tests given by him give any fair comparison as to the relative power obtainable from motors using light petrol of the specific gravity of 0·68 as compared with the heavy oils having a specific gravity of 0·88. Apart from the increased difficulty of vaporising the heavy oil, the efficiency obtained ought to be proportionate to the weight, and when these oils are used as heating agents, tested by the amount of water evaporated for a given weight of fuel, it is found in practice that this is so, and that the evaporative efficiency does vary with the weight.

His chapter on carburettors or vaporisers is somewhat disappointing. After all, the use of the carburettors is one of the main features which distinguish the modern petrol or heavy oil motor from the gas engine. After describing the two classes of carburettors for light oil, *i.e.* the surface vaporiser and the spray-making vaporiser, he describes a number of varieties of these two forms, without, however, giving any information as to their comparative efficiency or successful use. His conclusions as to the difficulties in using vaporisers heated by the exhaust gases or otherwise which are necessary when heavy oils are used are interesting and in the main correct. This part of the subject is of the greatest interest and importance, as an enormous development in the use of internal combustion engines for heavy vehicles would follow on a satisfactory solution of the problem of vaporising the heavy oils. Although for many years past the heavy oil stationary engine has taken its place as a well-known trustworthy commercial article, the use of heavy oil in the same internal combustion engine in motor cars has turned out to be a problem offering so many difficulties that up to the present hardly any maker of internal combustion engines has dealt with heavy oil with any reasonable degree of success.

One of the best-written chapters in Mr. Beaumont's book is that on electric ignition. This somewhat difficult matter is dealt with very exhaustively and so clearly that a reader need not be an electrical engineer to understand it. The various sources of electric energy which are used to give the spark and the sparking plugs and accessories necessary are, as a whole, correctly and clearly set out. I can hardly think, however, that Figs. 277 and 280, giving the diagram of magnetic field of the Bosch inductor generator, are correct. At the same time, they are scarcely necessary far making clear the author's meaning.

The author here gives at considerable length, not only the main features, but most of the details of construction of the vehicles used by the London Electric Cab Co. which had already proved a failure at the time that he wrote his description. Since that time great advances have been made in the construction of electrically driven vehicles, chiefly in the improvement of the accumulators themselves, so that we believe it has now been ascertained that electrically driven vehicles can now be put on the streets and worked at a very reasonable cost for maintenance; in fact, already the cost for maintenance of the accumulators is less than that of the rubber tyres.

Jenatzy's electrical vehicle, "La Jamais Contente," which attained a speed of 65·8 miles an hour, is described as having accomplished the greatest speed ever reached on a high road, but since that time much higher speeds have been recorded by the Mors and other petrol-driven vehicles during the time of the Paris-Bordeaux and other great French races.

Some space is devoted to the consideration of modern steam vehicles as made by Serpollet and by various American firms, such as Stanley and Whitney. It is to be regretted, however, that the descriptions of the flash boiler used by Serpollet are so very meagre, for undoubtedly this steam generator needs very careful study, as it bids fair to bring steam once more into use as a propelling power for light vehicles. Vehicles of the Stanley, or "locomobile" class as they are now called, are so common in the streets of London that everyone has noticed their satisfactory and quiet running. Mr. Beaumont's description of the "Stanley" vehicle is very complete.

A chapter is devoted to the description of the heavier motor vehicles used for transport of goods, and of which we have heard so much in connection with the Liverpool trials and more recently during the War Office motor-wagon trials at Aldershot. Several of these vehicles are described with considerable minuteness, but the author omits to tell us why it is that up to the present internal combustion engines have not come into use at all largely for these vehicles. Quite at the end of the book we find one or two chapters dealing with matters which are common to all classes of mechanically propelled vehicles, such as questions of vibration, balancing motors and pivoted steering axles. The latter chapter contains several errors, the chief of which are due to careless editing. For instance, in discussing the question of the side rub of wheels on the road on p. 570, we find distance H described as a number of degrees, and the proper angle of the outer wheel is called "a tangent to a curve." Again, in a description of the Peugeot float feed carburettor on p. 162, cock H is said to be for emptying the carburettor, whereas it is well known that it is not used for this purpose, but fulfils the rather important function of admitting any required quantity of air to the carburettor.

Apart from these errors, and several others of the same kind which are certain to be found in a work containing so much matter, the whole of the descriptive part and illustrations may be generally described as excellent. The same cannot be said of chapters iv., v. and vi., which deal with the general questions of road resistance, resistance due to gravity, and power required, air and wind resistance. In these the author has got together a number of tables recording the results of several experimenters on road resistances, which are confusing and contradictory, as he makes no attempt to explain them or reconcile them in any way.

The subjects of air and wind resistances, which are of some importance, are summarily dismissed in one page of thirty-six lines containing a formula, *i.e.* that connecting air pressure and velocity, which is most certainly incorrect. Here, however, the author can hardly be blamed, as this question of wind pressure and air resistance is one of great difficulty. Most of those who have experimented

in the matter during the last few years are not satisfied that the square law holds at all speeds, *i.e.* that the air resistance does not vary as the square of the velocity of the vehicle passing through it; that when bodies of irregular outline are moved through the air the resistance is not as the square of the velocity, but below 1000 feet per minute it probably varies at a lower rate than the square, at or near 1000 feet the square law is fairly correct, above 1000 feet per minute at a higher rate. It is probable that there is a point at which the curve turns over, otherwise it would be difficult to account for the small consumption of petrol on the racing vehicles during the French road races at the very high speeds registered.

Mr. Beaumont's work as a whole will be found a valuable one to those interested in these matters.

THE STELLAR UNIVERSE.

The Stars: a Study of the Universe. By Simon Newcomb. Pp. xi + 332. (London: John Murray, 1901.) Price 6*s.*

IN the consideration of a book such as this contribution to "The Progressive Science Series," it is advisable to ascertain the standard by which it is to be judged. For convenience, three classes of scientific books may be distinguished, each with its own criterion. There are, first of all, the text-books of a more or less didactic character, aiming at putting the student in possession of the salient facts of his subject; then we have the reference books, and in the third class we may place all volumes which aim at presenting aspects of a science in terms which may be appreciated by the lay as well as the scientific reader. Prof. Newcomb's book belongs to the third of these types, for it is intended to convey to cultivated minds a view of the state of knowledge of the various bodies in the stellar universe. The stars are considered individually and collectively in many of their characteristics and relationships, with particular reference to their general properties and the structure of the sidereal heavens.

It would be impossible for a man of science of such distinguished eminence as Prof. Newcomb to produce a book of mediocre quality in all its parts. Several of the chapters in the present volume are original contributions to astronomical knowledge and are not likely to be overlooked in future discussion. As instances we may mention the essays on the distribution of the stars and the statistical studies of proper motion. In the treatment of such subjects as these Prof. Newcomb is *facile princeps*, the result being that good material is selected and satisfactory conclusions are reached. But in the realm of astro-physics he wanders about with less definite aim and purpose, partly trusting to the counsel of friends as to the selection of subjects upon which to concentrate his attention. The result of this eclectic survey is not altogether satisfactory. A wide acquaintance with the new astronomy and a perfectly impartial spirit are rare attributes among writers on celestial science, but they are none the less desirable, and when they are not manifest the deficiency should be pointed out. This we propose to do, if only for the purpose of showing that there are other points of view beside those occupied by Prof. Newcomb.

It is easy to show that the outlook described is not only limited, but also often imperfect. Take, for example, the account of nebulæ. About forty lines have been found in the spectra of these bodies, yet Prof. Newcomb gives the impression that only four are known, namely the blue and violet hydrogen lines and the two characteristic nebular lines. Moreover, he makes the astounding remark that "none of these lines can be certainly identified with those of any terrestrial substance. The supposed matter which produces them has, therefore, been called nebulum." This is almost all that is said of the spectra of nebulæ, and it is an incorrect and incomplete statement of the facts. The suggestion that the lines at wavelengths 4341 and 4861 are due to the hypothetical nebulum has nothing to support it and cannot be taken seriously. For the rest, we can only say that astro-physics has progressed much farther in the knowledge of the lines and origins of nebular spectra than is implied in Prof. Newcomb's paragraph upon the subject.

As the whole question of the nature of nebulæ has to be referred to spectroscopy for an answer, a basis so slender as that described is unable to support a satisfactory edifice. If all that is known of nebular spectra were bounded by the remarks mentioned, the statement that "the light of a nebula does not come from solid matter, but from matter of a gaseous or other attenuated form" might pass muster among the uncritical. But, in addition to the lines of hydrogen and helium and the flutings of carbon, we have evidence of the existence in nebulæ of the metals iron, calcium and possibly magnesium, thus showing that we are not dealing merely with the permanent gases. So far as the spectroscopic evidence is concerned, the hypothesis that nebulæ consist of meteoritic and gaseous matter satisfies the facts better than any other; and even the dynamical objections mentioned are by no means "insuperable," as Prof. Newcomb describes them. Of course, "the amount of light produced by the collision of two such objects [meteorites] is only a minute fraction of the energy lost." But the remainder produces heat which may be sufficient to vaporise some of the constituents of the meteorites engaged, and it must be remembered that gases glow at a low temperature as well as at a high one.

The tendency to accept transcendental temperatures as characteristic of celestial phenomena shows itself in connection with new stars. We have as the cause of the new star of 1866 "an outburst of incandescent hydrogen, giving rise to a volume of flame of such magnitude as to be visible at the vast distance of our system." From what is now known of new stars it is probable that the Nova of 1866 had a spectrum of much the same kind as that shown by the new stars which have been observed in recent years. In any case, the "world on fire" theory is obsolescent, if not obsolete. Nova Aurigæ began the reform, for no detailed observations with modern instruments had been made before its day. Prof. Copeland detected and announced the presence of hydrogen in the spectrum on the first night he observed the star after receiving the postcard from Dr. Anderson announcing the discovery of the object. The spectrum was photographed at South Kensington a few days later, and on February 8, 1892, Sir Norman Lockyer announced to the Royal Society that "the bright lines K, H, *h* and G are

accompanied by dark lines on their more refrangible sides." Substantially the same announcement was made by Prof. Pickering about the same time. These are the facts, but they have been overlooked by Prof. Newcomb, who does not mention Sir Norman Lockyer or Prof. Pickering in connection with the Nova, but gives Profs. Campbell and Vogel the credit of the discovery of the double spectrum, and ascribes to the latter the demonstration of the existence of hydrogen a fortnight after the element had been detected in England. The question of priority is a small matter, but the principle involved is important, namely, that care should be taken in the selection of significant observations by whomsoever they are made. It can scarcely be said that Prof. Newcomb has exercised impartial judgment in this case.

Early observations of the occurrence of bright hydrogen lines in the spectrum of Mira Ceti are overlooked in much the same way as with Nova Aurigæ. Bright hydrogen lines were photographed in the spectrum of this variable star so long ago as 1886, and were observed by Mr. Espin about the same time; yet we read "Campbel found that near the time of maximum, the bright hydrogen line Hγ was very strong and overexposed on all the plates." The disregard of observation of Beta Lyræ is even more unsatisfactory. Prof. Myers's mathematical theory of the constitution of the star's system is described, while the numerous spectroscopic researches relating to the star are scarcely mentioned. The South Kensington photographs indicated long ago the presence of two bodies giving dark-line spectra—one like Rigel and the other like Bellatrix. The shifting bright lines are superposed upon the double-absorption spectrum, and the spectroscopic variations which occur bear a constant relation to the period of the star's changes of lucidity. Prof. Belopolsky's measures of the velocity of the star in the line of sight, and his proof that the radial velocity is zero when the star is passing through the primary and secondary minima, have practically proved that the chief cause of variability is eclipse by such bodies as those mentioned. Why, then, should these established facts be left out of consideration while space is given to mathematical inquiries which have yet to receive spectroscopic confirmation?

The study of these binary and multiple spectroscopic systems has already led to results of deep significance, and Prof. Newcomb devotes some attention to them. In connection with the account of Prof. Vogel's investigations of Algol, however, it is worth remark that the eclipse theory of the variability of the star was practically established by Prof. Pickering by observations of spectroscopic changes before precise measures of the radial velocity were made at Potsdam. Algol is a case of May wedded to December—a fervid body linked to one apparently decaying or dead. In true spectroscopic binaries like Zeta Ursæ Majoris (not Xi Ursæ Majoris, as is stated on p. 167), we have the component stars in more or less the same stage of development. From close binaries of this kind with periods of a day or so it is now possible to pass almost without a gap to the double stars with periods reckoned in centuries. Prof. Newcomb gives eleven years as the shortest period of a telescopic binary, but the star β 883 has a period of only half this length, which brings the two classes of binary systems closer together than he supposes.

Breaches of continuity are usually only apparent, and become filled as knowledge increases. We have passed the days of special creations, and are beginning to see a course of evolution in all natural processes. The biologist has adapted himself to this idea more readily than the astronomer, who looks askance at all attempts to discover a spectroscopic order of evolution in celestial bodies. Prof. Newcomb brings together a number of interesting facts concerning the structure of our universe, but he does not show much relationship between them. Why is it that nebulæ which give bright-line spectra, bright-line stars and new stars are almost exclusively confined to the Milky Way? For though it is true that diffuse nebulæ "are least numerous in the Milky Way and increase in number as we go from it in either direction," it is also true that there are more planetary nebulæ near the Milky Way than in any other part of the heavens. It is reasonable to suppose that there is a large amount of dark meteoritic matter in the region of the Galaxy, as well as a greater depth of stars. Sir Norman Lockyer has suggested this in explanation of the overwhelming number of very faint stars which occur in the Milky Way. Such stars may only be faint because of the partial extinction of light caused by fine particles of matter; so that the same stars would appear brighter if they happened to be nearer the galactic poles. Upon this hypothesis it is possible to explain phenomena which otherwise appear inexplicable; at any rate, it is as worthy of analysis as the "grindstone" theory of the structure of the universe.

It is too much to assert that no extinction or modification of light occurs in space. We can only analyse what reaches us, and it is just as logical to assume the existence of an absorbing medium as it is to neglect a possible cause which, while not contrary to any observed facts, facilitates the explanation of related phenomena. The test of any theory is not so much how it explains one group of facts or phenomena, but how far it admits of general application; and it is because the meteoritic hypothesis satisfies this condition that it claims attention. Most of us will agree with Prof. Newcomb in the remark, "So far as we can judge from the enumeration of the stars in all directions, and from the aspect of the Milky Way, our system is near the centre of the stellar universe." But the argument is nevertheless unsound. It would be just as reasonable for a horse tethered to a stake to conclude that the grass he was able to get at represented all there was in the world. We can only sound the depths of space so far as our instruments permit us, and the facts as to the distribution of stars or other celestial bodies must be considered in relation to others of a spectroscopic character before we are justified in assuming that the sun is situated towards the centre of our universe.

There are many other points in Prof. Newcomb's book which invite discussion, but they cannot be dealt with here. It is worth mention that no account is taken of Prof. Perry's reasons for believing that the sun may have radiated heat for much more than twenty million years, and that the results of studies of photographs of stellar spectra taken at South Kensington are entirely neglected. The misprints we have noticed are *Sirs* A. A. Common and Isaac Roberts (p. iv.), telescopic for spectroscopic (p. 12)

Goodrick for Goodricke (p. 102), Tebbut for Tebbutt (p. 126), Edinborough for Edinburgh (p. 139), and meteoritic theory for meteoritic hypothesis (p. 190). As was remarked at the commencement of this notice, the book presents many interesting problems on subjects with which Prof. Newcomb is familiar, but it leaves the reader still to seek a broad-minded statement of the position of spectroscopic work in connection with the study of the stars. R. A. GREGORY.

PRINCIPLES OF GEOGRAPHY.

Tarr and McMurry's Geographies. Second book, *North America.* Third book, *Europe and other Continents.* By R. S. Tarr and Frank M. McMurry. Pp. xix + 469, and xx + 574. (New York: the Macmillan Company. London: Macmillan and Co., Ltd., 1900 and 1901.) Price 4*s.* 6*d.* each.

THE leading idea of this series, of which the first volume only, that on "Home Geography," has been published in England, is that "Geography treats of the relation between man and the earth—a hill or a lake is worthy of mention only because it bears a relation to us, the men upon the earth; considered by itself it is not a part of geography." Without discussing this notable statement on its merits, we confess to finding its application in these volumes somewhat disappointing. It becomes an attempt to extend the methods of the elementary illustrated geographies to more advanced stages, and necessitates a degree of sketchiness which makes some parts of the books almost unintelligible and others misleading. On pp. 27 and 28 of vol. ii., for example, we find pictures of fur-clad Eskimos and half-naked savages of the tropics to illustrate the difference of temperature in these two latitudes, and only fourteen pages further on we are confronted with a vertical section of the atmosphere showing the complete general circulation. The circulation between the horse latitudes is compared to that caused by a stove in a room, and the rest is dismissed in the sentences, "Being cooled on account of its great height, the air of the anti-trades slowly settles, some of it coming to the surface at about a third of the distance to the poles. There it spreads out, a part continuing on toward the poles, a part returning to the equator as the trade winds." Given the analogy of the stove, what is the intelligent pupil to make of the "part continuing on towards the poles"?

Again, in connection with oceanic circulation, we find drift currents satisfactorily accounted for, but the cause of the many currents which cannot be thus explained is simply passed over. In describing the relation of ocean currents to climate, the authors fall into serious error, and the old story of the "Gulf Stream" carrying "one-half as much heat into the Arctic as reaches it from the direct rays of the sun" reappears once more. All the explanation given of the tides is, "When the sun and moon pull upon the earth, the ocean, being a liquid that can be moved, is drawn slightly out of shape."

The descriptive parts of these books are admirable; in the volume on the United States especially, the physical features, climate, means of transport, industries and commerce are treated with unfailing interest and clearness, and there is abundance of illustration and good maps; but the "physiographic basis" as here set forth—the attempt to account for modern distribution directly from first principles—must suggest to the boy who "sees difficulties" so many questions of which we do not know the answers that he will be apt to distrust the "principles" altogether, while the boy who accepts everything will receive a fatal impression of the simplicity of the universe. It is one of the advantages of geography that continual reference can be made, in teaching, to first principles, but the science is still a long way from the point at which a satisfactory text-book of the kind proposed by the authors can be written.

ELEMENTARY ZOOLOGY.

A Text-book of Zoology. By G. P. Mudge, A.R.C.Sc. Lond. Pp. viii + 416; 100 figures and 2 coloured plates. (London: Edward Arnold, 1901.) Price 7*s.* 6*d.*

THIS aid to the study of zoology differs in plan from most books of similar purpose. After a general introduction on the scope of biology, which will prove, we fear, a heavy meal for beginners, the author discusses (1) the comparative morphology of vertebrates, illustrated by dogfish, frog and rabbit, and by the lancelet (which has naturally a chapter to itself); (2) the morphology of cœlomate invertebrates, illustrated by crayfish, cockroach, freshwater mussel and earthworm; (3) the structure of Hydra as a type of acœlomate diploblastic invertebrates; and (4) the structure of Paramœcium and Amœba as types of Protozoa. Then follow chapters on reproduction and development, heredity and variation.

Mr. Mudge's exposition is clear and accurate, and his terseness is a feat in itself. Perhaps this striving after conciseness has inhibited the author, for while the chapters on heredity and variation, for instance, are vivid and interesting, there are too many pages in the body of the book which read like dull summaries and show no individuality of treatment or expression. Surely some individuality was needed to justify the repetition for the *n*th time of much that may be found in many other books.

We do not think that Mr. Mudge was wise in his choice of a title—"A Text-book of Zoology"—for this ticket is too big for his wares. A text-book of zoology cannot afford to leave out of consideration birds and reptiles, and half of the classes of invertebrates, or to deal so slightly with bionomics. And while we recognise the value of this new aid to the study of zoology in so far as it forces the student to realise what comparative anatomy means, we doubt whether this lesson is rightly learned when only a few types are compared. Thus, to be frank, is there more than practical convenience to justify the time-honoured position of the frog in schemes of comparative morphological study? As a cheap *corpus vile* on which the student may learn to dissect, the frog is useful—almost indispensable—but as a type for the study of the comparative morphology of vertebrates it is one of the most difficult. The figures in the book are clear and useful, but the prominence given to the coloured diagrams of various circulatory systems seems out of perspective.

THURSDAY, MARCH 20, 1902.

REFORM OF THE TEACHING OF MATHEMATICS.

British Association Meeting at Glasgow, 1901. *Discussion on the Teaching of Mathematics, which took place on September* 14 *at a Joint Meeting of two Sections, Section A, Mathematics and Physics, Section L, Education.* Edited by John Perry. Pp. vi + 101. (London: Macmillan and Co., Ltd.) Price 2*s*. net.

PROF. PERRY'S views concerning the teaching of mathematics have been expounded often in the columns of NATURE and elsewhere, and have aroused a great deal of interest. It was a happy idea to bring about a discussion of these views at a joint meeting of the mathematical and educational Sections of the British Association. The report of that discussion has been issued as a separate small volume. It contains the introductory address delivered by Prof. Perry, a specimen syllabus prepared by him for use in training colleges, the discussion that followed the address, written remarks on the subject communicated by several teachers who did not take part in the discussion, and Prof. Perry's reply. The discussion was restricted to what may be called a possible school range of mathematics; the teaching of advanced mathematics at the Universities was scarcely touched upon. As an outcome of the discussion, a committee of the British Association was appointed

"to report upon improvements that might be effected in the teaching of mathematics, in the first instance of elementary mathematics, and upon such means as they think likely to effect such improvements."

The movement thus initiated is important. Many of the more enlightened teachers of mathematics in Britain have long been dissatisfied with the conditions under which they have been compelled to work; and efforts in the direction of reform have been made, in particular by the Association for the Improvement of Geometrical Teaching. The smallness of the results achieved by those efforts is to be traced mainly to the action of the chief examining bodies; but there are not wanting signs that these bodies are now less complacently conservative than they have been in the past. It is earnestly to be hoped that the indicated change of attitude may turn out to be real. The handy publication under notice should be of great assistance to those who are agitating for reform.

The movement is in great part a reaction against the pedantic and unpractical character of the habitual teaching of mathematics in schools. This character belongs both to the methods of presenting particular subjects and to the order in which the subjects, and the parts of the subjects, are studied. The methods and the order now in vogue are not, of course, a system devised purposely; they have been arrived at gradually, and are sanctioned by tradition. The principles of the proposed reform may be stated broadly as follows:—(1) The way for every abstract generalization should be prepared by intelligent practice of comparatively concrete processes, chosen so as to stimulate inquiry; (2) whenever a choice of alternative orders is offered, that order should be preferred which conduces best to the application of mathematics to practical needs. A subsidiary principle of reform would be that all purely artificial and unimportant developments should be omitted. The principles thus stated will not perhaps excite much opposition; yet far-reaching and radical changes would be required to give effect to them. One result that may be expected to follow from such changes would be that the study of the elements of mathematics would become a better preparation than it is at present for the study of the more advanced theories. The mathematics of most of our elementary text-books is felt to be almost as much out of touch with modern mathematics as with everyday life. This conviction has had some share in promoting the movement in favour of change.

As regards geometry, the thoroughgoing adoption of the above-stated principles of reform would lead in the first place to the introduction of courses of practical work in drawing and measuring, which would precede and accompany the study of demonstrative geometry; and it would lead in the second place to a great simplification of that study. That simplification would consist partly in the abandonment of Euclid's "Elements" as a text-book. The difficulty of finding a generally acceptable substitute for Euclid was fatal to the proposals of the Association for the Improvement of Geometrical Teaching, and the controversy between the supporters and the opponents of Euclid has been a main feature of all discussions concerning the improvement of the teaching of mathematics in this country. Now it may be contended that we ought not to attempt to present geometry to children as a formal system deduced from a minimum number of assumptions; but that our objects should be to impart knowledge of the properties of geometrical figures and to cultivate power of geometrical reasoning. Upon the general adoption of this view of the true objects of geometrical teaching, the above-mentioned difficulty would disappear; for it is safe to assert that these objects can be secured better without Euclid's book than with it. In this matter the French are far ahead of us. Their text-books of geometry have been evolved by a natural process of development from the "Géométrie" of Legendre; and text-books similar to those of France are in use in Germany, Italy and the United States. It is far from my purpose to suggest that British teachers should now adopt as a substitute for Euclid a translation of a French book or any other foreign book. In all these books too much attention, as I think, is paid to the development of a formal logical system, with the result that much space is occupied in proving propositions that are sufficiently obvious without proof. We have yet to work out for ourselves the method that is best suited to our educational needs and national temperament. This cannot be done without freedom from the tyranny of an orthodox standard; nor can it be done in a hurry. Changes will have to be made gradually. In this connexion we may note that the memorial sent by some schoolmasters to the committee of the British Association (NATURE, January 16, 1902, p. 233) points out a promising method of beginning to make changes. If the chief examining bodies would now sanction such a departure from existing practice as is there proposed, progressive reform would become possible.

The contention that Euclid's "Elements" is an unsuitable text-book is borne out by a critical scrutiny. The book was an attempt to deduce a complete system of geometry from a minimum number of assumptions, contained in definitions, axioms and postulates. No such attempt, even if completely successful, can possibly appeal to immature minds; and it is well known that Euclid's attempt, in spite of its many conspicuous merits, is logically defective. This would not matter very much if it were otherwise well adapted to effect the two objects which we have noted above as the true objects to be aimed at in teaching geometry. Notoriously it is not so adapted; striking instances of its deadening effect upon the minds of average boys have been recorded by Prof. Minchin and others. Such instances may fairly be cited in opposition to the claim, urged by the supporters of Euclid, that his system affords valuable mental training; and this claim does not gain in force when it is observed that most of the men who have undergone the training appear to be unable to appreciate the logical defects of the system, and that they accept without question the absurdities that are often made to do duty, in our text-books of analysis and mechanics, as definitions or as proofs. Further, the tacit agreement to drop Euclid's fifth book has robbed his sequence of its significance. This book is really the great contribution of antiquity to the problem of irrational numbers—perhaps the central problem of mathematics. It is certainly the keystone of Euclid's system. Without it, there is no reason why proportion and measurement, treated arithmetically, should not take a much earlier place in a system of geometry. In elementary stages, it will probably be best to postpone all questions of incommensurable magnitudes and irrational numbers; but sooner or later, in the training of a mathematician, such questions must be faced. The Greeks approached arithmetic through geometry, and for two thousand years Euclid's fifth book was the only theory of irrational nnmbers. Now, however, the Greek way is not the only way, nor, as I believe, the most excellent. There exists now a complete arithmetical theory of irrational numbers; and the theory of exact measurement of incommensurable, as well as of commensurable, magnitudes can be founded on a secure arithmetical basis. This revolution of mathematical thought was accomplished in Germany in the second half of the nineteenth century; its full effect has yet to be felt.

But geometry is not the only branch, even of elementary mathematics, of which the aspect would be changed entirely by giving effect to the above-stated principles of reform; nor is the need for improvement confined to the teaching of elementary mathematics. In algebra, for example, the changes advocated in the book under notice, or those proposed in the memorial of some schoolmasters already referred to, would constitute great improvements in the method of presenting the subject. Here again the French text-books are much better than most of ours. In analysis generally, the traditional order of the topics stands in need of drastic alteration—boys and girls ought not to be taught to expand the circular functions in infinite products before they have ever plotted a graph or differentiated the simplest expression. Prof. Perry has been a constant advocate of graphic methods and of the early study of the differential and integral calculus. He holds that this study should precede that of many things which now come before it, *e.g.* advanced analytical geometry of conics; this view is put forward on the ground that such an order would be more helpful to those students who will afterwards require to use mathematics in the practice of their professions. They are not the only students who would gain by the change. The educational value of mathematics would be increased enormously. Mathematics becomes an instrument of liberal education, not merely by the practice of processes—they are means to an end—nor yet by the storing of information, though knowledge of facts is an element of culture—but by the formation of exact ideas as regards both the definiteness of its fundamental notions and the inevitableness of its results. The impression that is made upon the mind, when one realises the inexorable necessity of the conclusion of a chain of reasoning, is the element in mathematical training that has been emphasized the most by those who support the claim of mathematics to be considered an integral part of a liberal education; but it may be held that the illumination to be derived from any of the fundamental notions of mathematics—such notions, for example, as proportion, continuity, vector, group—when they are thoroughly grasped, is a not less important element from the same point of view. The traditional order of study has tended to obscure the fundamental notions and the general drift of the arguments under a cloud of secondary developments. That the differential and integral calculus can be presented at such a stage as that indicated by Prof Perry, in a manner so practical as to suit the student of engineering, and at the same time so rigorous and so luminous as to be a worthy means of liberal education, has been shown by more than one recent treatise. The examinations that have most influence upon the order of study near this stage are probably those for entrance scholarships at the colleges of the older Universities. A few reforming tutors might now initiate a change that would produce a very great effect.

It is unnecessary here to follow out the application of the principles of reform to mechanics, or to the remaining subjects of a school course of mathematics. The book under notice contains numerous suggestions on these heads. Some readers may be inclined to think that in the introductory address, and in some of the subsequent speeches, undue prominence was given to the needs of students who are destined to become engineers, or teachers in primary schools. A view that is held widely, but has not perhaps been emphasized sufficiently, is that, in the stage of ordinary school work, the course that is most suitable for such classes of students is also precisely the best for those for whom mathematics is meant to be a means of culture and for those who have the ability, and will afterwards have opportunities, to assist in the development of mathematical theories. To bring such a course into general use will require much persistent effort, directed continually to one end; and the first step will necessarily be the conversion of examiners and of the bodies that make regulations for the conduct of examinations. The future of mathematical teaching in this country is in their hands.

A. E. H. L.

A STUDY IN FISH MORPHOLOGY.

Pleuronectes. Liverpool Marine Biology Committee's Memoirs on Typical British Marine Plants and Animals. No. viii. By F. J. Cole and Jas. Johnstone, B.Sc. Pp. 252; 11 plates, 5 text figures and a table. (London: Williams and Norgate, 1901.) Price 7s.[1]

OF the now numerous publications of the Liverpool Marine Biology Committee which have appeared since its foundation, none are of greater service to zoologists and students than those of the series to which the volume under review belongs. They are each a detailed study of some individual organism, prepared by a writer or writers specially familiar with the group to which it belongs; and under this guarantee of authority, they are consequently welcome and most useful wherever the zoology of the British seas is studied or taught. The first memoir, on the "Ascidian," by Prof. Herdman (to whom honour is due for having inspired and initiated this most admirable series), appeared but in 1899; and in the interval of little more than two years which has elapsed, there have been published seven others—the present volume being the eighth. In bulk and descriptive detail, this is by far the most extensive and elaborate yet issued, since it is nearly three times the size of its heaviest predecessor, and is illustrated by eleven plates as compared with a previous maximum of seven. When, however, it is remembered that it has two authors and deals with a verteb rate, and that it exhausts not only the orga nology, but treats of the life-history, habits and economic aspects of the fish selected for treatment, it is evident that a just allocation has been given it. Indeed, in its method of treatment it is at once both wider and more special than its predecessors.

Both authors have already so distinguished themselves as trustworthy investigators, at Liverpool and elsewhere, that their cooperation gave promise of a good result, and in the end our highest expectations have been fulfilled.

The introduction to the book opens with a consideration of classification, the value of the Müllerian subordinate term "anacanthini" (now unquestionably doomed) and of the less familiar "heterosomata" being duly explained. In dealing with the external characters, the more recent work on chromatology is adequately incorporated, with due mention of authority; and while the descriptions of the lateral line organs and scales are fully up to date, and the "breathing valves" are duly recognised, slight error is obvious only in the application of the terms descriptive of the condition of the tail to that organ and not the fish itself. The subjects of torsion and asymmetry, as involving the head and dorsal fin and leading up to accurate definitions of the "eyeless" and "ocular" sides, are extremely well handled, both in this introduction and in a subsequent section, following that treating of the eye-muscles, which play so important a part in the processes involved and in furnishing a clue to their real nature. Rival theories are discussed, to the denunciation of those of Cunningham, based upon the study of the sole, certain other of whose observations come in for criticism in many pages of this work.

The osteological chapters come next in order of succession, and they are thoroughly good and sound. The bones of the "eyeless" and "ocular" sides are alternately described; the compound nature of the pterotic and sphenotic elements is fully considered, in its bearings on both morphology and terminology; the absence of the left nasal is explained; and the details in respect to which the inter-maxillary cartilage enables the plaice (in contradistinction to other Pleuronectidæ) to pick up food on its eyeless side, are made admirably clear. The vertebral column and fin-supports are fully considered; and while we doubt the advisability of retaining the term "atlas" for the first vertebra, we welcome the adoption of "axonost" and "baseost" and the recognition of the work of Traquair, Bridge, and others who are named. We regret, however, that while our authors were thus far revising their terminology they did not, for once and for all, replace the term "anal" in ventral for the post-anal median fin.

Concerning the anal spine, it is noteworthy that the authors have been at immense pains to be perfectly sure that this does not project uncovered during life; and it may be said that no less labour has been bestowed upon the accurate determination of the nature and precise limitations of the pancreas, the lymphatic portion of the head-kidney, the thymus gland, and other organs which text-book writers are too apt to sketchily consider. Their desire to be thorough at all costs is, in fact, one of the distinguishing features of their book; and consequently, we find descriptions of the adult supplemented by comparison with the young, as in their account of the development and retrogression of the thymus, of the thyroid and suprarenal organs, of the hypoblastic origin of the "bladder" (which we rejoice to find termed the *urocyst*) and other allied parts. In all this and a great deal more their memoir is a record of laborious research, done for the love of the work and with the determination to be exact; and no less praiseworthy are their literary efforts, which have led them, when called upon to deal with things of doubtful homology or function, to state fully alternative possibilities, with due reference to authority, as, for example, in their treatment of the "interclavicle" and the "pyloric cæca."

The section dealing with the blood vascular system calls for no especial comment, except that it is accurate and well done, and that a good service has been rendered in a *résumé* of the chief conditions assumed by the pseudobranchial vessels. The authors' extreme caution is again obvious, in their refusal to decide upon the homology of this pseudobranch (in the absence of a related afferent branch of the ventral aorta) until dealing with its inn rvation. And this leads naturally to the consideration of their section on the nervous system, which, as might be expected from the senior author's work, is their *pièce de résistance*. In the portion of this which deals with the cranial nerves, we are taken at once into a dissertation on the two-root law of Bell and the four-root theory of Gaskell; and, apropos of the far-reaching investigations of Strong and the labours of Herrick on Menidia, to a classification, based on the "component theory" and work done under the conviction that the whole course of these

[1] Like three of its predecessors, which were written wholly or in part by members of the staff of the Lancashire Sea Fisheries Laboratory, the memoir is also incorporated as an Appendix in their Annual Report Rep. x. 1901).

nerves should be determined by means of serial sections. Rather too much this to expect from the ordinary student! especially when it is seen that the classification discriminates between five systems (viz.—somatic-afferent and -efferent, viscero-afferent and -efferent, and acustico-lateral) "each delimited by a uniformity of peripheral termination and a special characteristic origin in the brain," and each liable to "appear in a variable number of cranial nerves as a component of those nerves." Our authors tell us they have adopted this method for the plaice, and in proceeding to the systematic description of its cranial nerves they deal with them in order of functional association. The olfactory, optic and eye-muscle nerves are first considered; then the fifth and seventh; after the study of their root-ganglia, the eighth, ninth and tenth, completing the series. With the spinal nerves, the fourth is described first, and the first three later in order of succession, because they are less typical and by virtue of their especial relationships to the pectoral member. It is impossible here to go more fully into the details of this very technical subject; suffice it to say that all is most admirably set forth, and that while a really good description of the sympathetic system is given which may serve as a model to writers of the future, both the giant cells of the cord and the most recently revived Reissner's fibre are described and discussed with full bibliographic treatment. Special discussion is given to the question of the innervation of the pelvic member, in its bearings on translocation and nervous substitution, as a guide to homology. The authors' arguments under this head have an especial interest, in the recent announcement by Dr. A. Smith Woodward of the startling discovery that, in Cretaceous times, teleostei of the clupeoid type had already translocated the pelvic fin into the jugular position.

Following this are sections dealing with the sense organs. Kyle's discovery of a pleuronectid with a naso-pharyngeal aperture and Holt's "recessus orbitalis" meet with due recognition, and here again all is admirable and fully up to date. The aforementioned thesis on asymmetry is conveniently introduced at this point, and there follow sections on the ear and reproductive organs, with a *résumé* of the present state of our knowledge concerning the sexual organs of the female teleosteans in general, in which Huxley's terminology is employed.

The book closes with an appendix, containing valuable information on spawning and the spawning season, on the maturation and structure of the egg, on oviposition, fertilisation, development and metamorphosis. Rate of growth, the nature and causes of migration and distribution, are duly dealt with, and there follows a brief sketch of the plaice fishery in northern European waters, with some sound advice to the practical fisherman. In not a few pages in the book there are hints as to the work of the future, as, for example, at the very outset, where there are described a sporozoon and a myxosporidian yet to be determined.

Of the eleven plates, all are admirably clear, and figures useful as are those of the cranial nerves, the olfactory sacs and the sympathetic system are most welcome. It is well known that in the production of this series of memoirs the cost of illustration has been largely defrayed by private donation. In the present case the publication committee of the Victoria University have performed this graceful task, and we congratulate its members upon their bargain. A better treatise on a single animal form there hardly exists, and while we would tender to editor, authors and all interested or concerned our heartiest thanks, we cannot refrain from an expression of national pride, in the extent to which it is evident from the pages of this work that the science of comparative ichthyology is essentially English. The book reflects the influence of the schools in which its authors were trained, and is a credit to them and to science in Britain. Our only fear concerning it is that it will be found too voluminous for the mere student, of whom so much is expected in so short a time. There is a danger that at first glance he would be repelled by the great amount of detail, and that thereby the subject of zoology might suffer. Selection can, however, always be arranged under a competent teacher, and for those desirous of specialising in ichthyology we could recommend nothing better. The book is healthy in the extreme, and while it will educate the student on sound lines, it will arouse in him the desire for reinvestigation and research, no opportunity of directing attention to which has been lost.

THE GOLD OF OPHIR.

The Gold of Ophir: Whence Brought and by Whom? By A. H. Keane. Pp. xviii + 244. With one plate and one map. (London: Stanford, 1901.) Price 5*s*. net.

IN the little volume before us Prof. A. H. Keane has undertaken an inquiry into the vexed question of the site of Ophir, and the source of the gold which the Hebrew Scriptures assure us was brought from that place to Solomon, son of David, by ships of Tarshish. The author himself feels that some apology to the reader is necessary, and that some explanation is due to him for having taken up the subject at all, and it is our duty to say at the outset that we wish he had left it for discussion to the class of people who triumphantly assert that Rhodesia is Ophir, and that Britons inherit this colony (which was founded by masterful Mr. Rhodes) as their natural right because they are descendants of some of the tribes of Israel. Prof. Keane thinks that so much evidence has accumulated on the subject during the last thirty years that it is time the question was reopened, and not only reopened, but decided once and for all. The evidence he refers to consists of the results obtained from the exploration and study of Rhodesian remains, from the Himyaritic inscriptions found in central and southern Arabia by Glaser and others, and from the explorations of the "Arabian frankincenseland" by the late Mr. Bent, and from parallels between the social and religious customs of the Malagasy inhabitants of Madagascar and "their Himyaritic, Phœnician and Jewish masters from the northern hemisphere." Incidentally we may mention that Dr. Carl Peters, in 1901, enunciated the extraordinary view that, not only was the site of the Ophir of the Bible to be found in Rhodesia, but that Ophir was to be identified with the Punt of the Egyptian inscriptions.

Prof. Keane has devoted several chapters of his little

book to attempting to prove his theories by appeals to facts philological and geographical; but all that can be said for his arguments is that if every assumption is correct, the deductions which he makes may be true, but if almost any one of them breaks down, his whole fabric must collapse. For example, Prof. Keane says unhesitatingly,

"the original Punt was South Arabia (Arabia Felix, Yemen), whence the name was extended to Somaliland during the eighteenth dynasty, say, about 1700 B.C."

But this is impossible, for in the sixth dynasty Punt was in Africa, and was probably reached by way of the Nile; and as the inscription of Her-khuf, formerly at Aswân and now at Cairo, contains the oldest mention of Punt in such a way that its position can be traced, we see at once that, so far as this remote period is concerned, Prof. Keane has no satisfactory authority for his statement, "the original Punt was South Arabia." The Punt of the eighteenth dynasty was reached in exactly the same way as it was reached in the reign of Seānkhka Rā (eleventh dynasty), and all the Egyptological evidence available goes to show that the region visited by the Egyptians at both periods was in Africa.

Prof. Keane thinks little of the evidence which Dr. Peters has deduced from the "*ushabte* figure impressed in a mould" which he found in the middle of Africa during his last expedition, yet he accepts the description given of it to the effect that it has "in each hand a scourge instead of a hoe." If the figure is an *ushabti* figure, and was really made in ancient days in a region far to the south of Egypt "for a courtier of Thothmes III.," the objects in the hands must have been intended to represent the flail and the hoe of Osiris, otherwise the whole figure is meaningless. In any case, how can it have a curious significance (p. 35) because "it is armed with a scourge in each hand, and [was] picked up in a mining district"? Let us hope that this wonderful figure may be placed somewhere so that it may be inspected by those interested in the matter.

Prof. Keane relies too much upon the statements of the late Mr. Bent in the deductions which he makes about the ruins at Zimbabwe, and this is the case also in respect of the views of the Hon. A. Wilmot, who wrote a volume entitled "Monomotapa," and who adopted nearly all Mr. Bent's views. Mr. Bent was an intrepid traveller and an accomplished gentleman, but he knew no Semitic language and his training as an archæologist was rather classical than anything else; his opinion on all Phœnician matters was, therefore, that of an intelligent but untrained amateur.

Our want of space prevents the possibility of discussing many of Prof. Keane's philological dicta, and we must pass on to his

"important conclusions," which he trusts "may now be considered fairly well established, and may therefore legitimately take the place of the many theories and speculations hitherto current regarding the 'Gold of Ophir,' its source and forwarders" (p. 194).

These are:—Ophir, on the south coast of Arabia, *i.e.* Moscha, or Porters Nobilis, was the distributing market of the gold of Havilah, or Rhodesia. The mines of Rhodesia were first worked by South Arabian Himyarites, who were followed in the time of Solomon by the Jews and Phœnicians, and these very much later by the Moslem Arabs and Christian Portuguese. Tarshish was the outlet for the precious metals, and was near the modern Sofala. The Himyarites and the Phœnicians reached Havilah through Madagascar, where they maintained commercial and social intercourse with the Malagasy natives. With them were associated the Jews, by whom the fleets of Hiram and Solomon were partly manned. There is, of course, something to be said for all these views, because each represents a possibility, but the facts required to prove them are wanting. Nevertheless, Prof. Keane's book is as valuable as it is interesting, because it has put the question on a scientific base, and we are glad to see that he has freed himself from the ordinary traditional trammels in dealing with it. Moreover, we must acquit him of all mercenary motives in trying to prove that the gold which Hiram and Solomon's fleets obtained from Ophir came from Rhodesia, for so far as we know, he has no pecuniary interest in the mining operations which have been carried on in that wonderful country during recent years. The "notes" which he gives will be very useful to other workers in the same field, and his index facilitates the profitable perusal of the present book.

EXPERIMENTAL WORK WITH GASES.

The Experimental Study of Gases. By Morris W. Travers, D.Sc. With preface by Prof. W. Ramsay, D.Sc., F.R.S. Pp. xii + 323. (London: Macmillan and Co., Ltd., 1901.) Price 10*s.* net.

IN 1857, Robert Bunsen published the first edition of his classical work "Gasometrische Methoden," and twenty years later a rewritten and enlarged edition of the same, which still ranks as a standard text-book on the subject. We think it is not too much to say that since that date no more important work has been published on the properties of gases in general than the one now before us. The progress made in our knowledge of the subject has probably been at least as rapid as in any other department of chemistry, and the discovery within the last half-dozen years of five new elementary gases, in the investigation of the properties of which Dr. Travers has taken a prominent part, would alone afford justification for this volume, did it contain nothing else of merit.

The volume consists of 320 pages, with numerous illustrations, most of which appear to be original and not merely reproductions from current text-books. The first portion of the book is taken up with a detailed description of the apparatus used, and the methods employed in the preparation of gases in a state of purity and their accurate measurement and analysis. Then follow chapters on the gases of the helium group, the determination of density and the relations of pressure, temperature and volume, the liquefaction of gases, and finally their properties and the constants relating to them. Careful perusal of the work leads us to the impression that in this case (as is by no means always the rule) the best chapters are those on the subjects with which the

author is peculiarly at home, namely the sections dealing with the gases of the helium group and with liquefaction. On the other hand, the chapter on the preparation of pure gases is somewhat disappointing, not so much on account of what is said as because of what is left unsaid.

In the introductory fifty pages we notice much valuable information, obviously the outcome of experience, regarding the construction of apparatus, such as Toepler and Sprengel pumps, and practical hints on such matters as the cleaning by means of zinc dust and hydrochloric acid of glass apparatus which has become dirty by long-continued use with mercury.

While referring to pumps, we may mention that the statement on p. 15 that a filter pump with a good head of water will reduce the pressure in a vessel to the vapour-pressure of water at the time is well inside the mark. In the writer's experience it is not uncommon to obtain by selection a filter pump which will reduce the pressure to much more nearly one millimetre than 15 to 20 mm., the latter being a degree of vacuum quite easily attainable with almost any good pump and moderate pressure.

For flexible connections to stand high pressures or vacua, the thin weldless steel tubes recommended by Dr. Travers should always be protected by an outer sheath consisting of a compo tube slipped over the steel and drawn tight on to it through several holes of a draw plate. This prevents the steel suffering, as it is very liable to do, from too sudden bends or from accidental crushing.

In attempting to preserve for long periods gases collected in a sample tube over mercury, great caution is needed in seeing that the surfaces of the tube are quite clean and free from grease, and that the mouth dips well under the mercury in the vessel in which it is placed. Otherwise slow inward diffusion of air may occur along the walls.

In the chapter on the preparation of pure gases we should have liked fuller descriptions of the methods, and more of them, the details in some cases being decidedly meagre and several of the methods recommended being only suitable for the preparation of very small quantities of gas.

The electrolytic preparation of hydrogen and oxygen from dilute sulphuric acid is a method which does not receive the author's commendation for ordinary use, but most of the disadvantages disappear, at least in the preparation of oxygen, if phosphoric acid is taken in the place of sulphuric.

No mention is made of the electrolysis of hydrochloric acid and the preparation of the intensely interesting mixture of chlorine and hydrogen sensitive to light, although this experiment is attended with peculiar difficulties.

On p. 74, reference is made to the "Paris kilogram," an ambiguous and unnecessary term if the now almost universally recognised international kilogram is meant (let us be thankful that there are not as many kilograms as ohms), and on p. 130 we find the statement,

"The results (weighings of gases) are reduced to the values which would have been obtained at sea-level in latitude 45°. They may be reduced to the Paris standard by multiplying by 1·000316."

We fail to see why, after having reached lat. 45° and sea-level, some charm in the local value of gravity should induce us to come back and reweigh the gas at Paris. It may be mentioned here that the very divergent values quoted on p. 74 for the mass of a cubic decimetre of water at 4° ought to be replaced by more modern data, which agree in fixing $999·95 \pm ·02$ grm. as a much more probable value.

We are glad to see that in the chapter on gas analysis Dr. Travers has weeded out from the many forms of apparatus and methods employed those only suitable for *technical* use, describing only those capable of scientific accuracy, with copious references to the most recent work on the subject. The usefulness of the chapter would, however, have been increased had a description been given of some form of complete apparatus for general gas analysis, such as that of Prof. MacLeod, or one of its later modifications.

We may sum up the chapter on the preparation and properties of the gases of the helium group by saying that it contains practically all that is known on the subject.

Temperature measurement by the gas thermometer is gone into at considerable length; and the convenient and accurate compensated constant-pressure thermometer of Prof. Callendar is illustrated and its working described in detail.

In the chapter on the liquefaction of gases, a full account is given of Dr. Travers' own experiments on the liquefaction of hydrogen, which is a reprint, with additions, of his recent paper in the *Phil. Mag.* This concludes with an account of the cost of these experiments, in which it is stated that, after an outlay of about 250*l.* on the complete plant, an expenditure of about 1*l.* each time covers the cost of making liquid hydrogen.

Anyone familiar with some of the palatial laboratories of many of the physical chemists abroad, visiting for the first time the dingy dwelling of the chemical department at University College, which the school of Ramsay has now made classic ground, could not fail to be surprised at being shown the hydrogen liquefier fitted up in a disused lavatory, and to hope that in the coming London University scheme physical chemistry may find a worthier home.

To return to the book, it appears to be accurately printed, and although we have verified many of the numbers and constants given, the errors we have detected are not numerous.

Among the slips may be pointed out, Kaysir for Kayser; Wülmer for Wüllner; Kirschoff for Kirchoff. Fig. 102, which is repeatedly referred to, appears to be missing.

We may conclude by stating how much a study of the book has emphasised in our own mind the importance of Prof. Ramsay's concluding sentence in the preface he has written directing attention to the lacunæ still remaining in many branches of our knowledge, and by heartily congratulating Dr. Travers on his labours, which have produced a book worthy of a place in the reference library of every student of modern chemistry. J. A. H.

OUR BOOK SHELF.

Tafeln zur Theoretischen Astronomie. By Julius Bauschinger. Pp. 148. (Leipzig: Wilhelm Engelmann, 1901.) Price 12*s*. net.

MOST astronomers are familiar with the very excellent volume entitled "Formeln und Hülfstafeln für Geographische Ortsbestimmungen," by Prof. Th. Albrecht; this work contains in a small compass most of the formulæ and tables required for geodetic work, and the very clear descriptions of the processes involved make the volume a veritable *vade mecum* for those employed on such work.

The volume before us does for "theoretical astronomy," that is astronomy dealing with the determination of the positions and orbits of bodies in space, what the above-mentioned book does for geodetic work, and the main attempt of the compiler has been to bring together in a compact and complete form all that is required by the computer, rendering it unnecessary for him to seek aid from other books. In this class of work the computer has generally to consult more than one volume in which suitable tables for his calculations occur, such as, for instance, the valuable work of von Oppolzer, and in some cases the tables are not of the most convenient form.

The present volume, therefore, serves a most useful purpose, and the arrangement of the tables leaves, so far as can be seen without actually working out a problem, little to be further desired. The tables, which are forty-five in number, are arranged under six sub-heads. The first of these divisions is devoted to such objects as conversion of time into divisions of arc, mean time into sidereal time, &c., and *vice versâ*. The next is for the determination of the true anomaly from the time and *vice versâ*, for elliptic, parabolic and hyperbolic motion, and here three methods for the solution of Kepler's equation are given; two of them are based on Tietzen's solution and are purely computational, while the third is after the graphical method of Waterston and Dubois and is accompanied by two loose charts.

The third set of tables deals with the part of the problem relating to the determination of the first approximate orbit, in which both Euler's and Lambert's equations are required; while this is followed by tables which serve for the computation of special perturbations and improvement of the elements determined by the first approximation.

The fifth part gives the means for calculating precession, nutation, aberration and parallax, and contains a list of the chief observatories of the world and their coordinates, with data for parallax determination.

The sixth and last section is formed of miscellaneous tables which are of general use in work of this kind; thus we have formulæ and tables for interpolation, differentiation and integration, mechanical differentiation, &c., concluding, amongst others, with mathematical, astronomical and geodetic constants.

All the tables which depend on astronomical constants have been recalculated and based on the Paris Conference constants, while each table is clearly explained and in most cases accompanied by an example worked out step by step.

This book of tables will, with very little doubt, be of considerable service both to the experienced computer and to the student who is working out orbits for the first time. Great praise is due to the compiler who has performed this laborious task with so much care and with such success.

An Elementary Treatise on Alternating Currents. By W. G. Rhodes, M.Sc. (Vict.). Pp. xii+211. (London: Longmans, Green and Co., 1902.) Price 7*s*. 6*d*. net.

MR. RHODES' treatise on alternating currents can hardly be regarded as particularly elementary, since he certainly assumes in his readers a preliminary acquaintance with the principles of the subject. We are inclined to think that although the mathematical parts are good, the treatment on the electrical side, especially in the simpler parts, leaves a good deal to be desired. Thus on p. 23 the quantity $2\pi n\mathrm{L}$ is defined as the reactance, whereas a few pages further on (p. 31) this name is used for the fuller expression including self-induction and capacity, without any explanation as to why the same term is used in both cases; the same observations apply to the definition of impedance. One may be pardoned for laying stress on such faults as these, since the subject is at best a difficult one, and without a perfectly sound knowledge of the fundamental ideas, the student will never make much progress.

The author has aimed at using the calculus as little as possible, and, where its employment is inevitable, has given the solution of an equation in the text and the working in the appendix. Many of the problems are solved by vector algebra, to an explanation of the principles of which a short chapter is devoted. The design of transformers and the theory of the synchronous motor and polyphase currents are treated at some length. It is to be noted that although hysteresis is of necessity considered, it is nowhere adequately explained. Another omission is that no description is given of any method of determining the wave form of an alternating current or P.D., although there is a chapter on the subject of alternating measurements. We do not doubt that the book will be found very useful, but its value would be greatly increased by a more careful attention to thoroughness and completeness. M. S.

Cyanide Practice. By Alfred James, Member of the Institution of Mining and Metallurgy, F.G.S., F.C.S. Pp. xii + 174. (London: E. and F. N. Spon, Ltd.; New York: Engineering and Mining Journal Incorporated. Not dated). Price 15*s*. net.

ALTHOUGH there are now a number of books in which some information on the cyanide process can be found, a full and satisfactory description of it has not yet been written, and can hardly be expected until more experience has been gained. Meanwhile, no instalment of the complete account can be more interesting and important than that giving a record of the experience and views of Mr. Alfred James.

Mr. James was the pioneer of the process in South Africa in 1888, and to him belongs the credit of adapting it to the treatment of auriferous tailings at a time when cyanide was in some danger of being set aside for the time owing to the difficulties encountered in the treatment of virgin ores with its aid. When a good start had been made, and the value of cyanide solutions demonstrated, a host of workers took up the task and a vast industry was created on the foundations laid by Mr. James; but the part he played in promoting the prosperity of the Witwatersrand gold mines will always be remembered with gratitude by metallurgists.

As might be expected, the book is full of good things, details of construction of vats and extractor boxes useful to the general manager, hints on extraction and precipitation designed to aid the millman, and hitherto unpublished researches on bromocyanide which will be read with avidity by the chemist. The method of arrangement, however, leaves something to be desired. Some sections consist of papers read at various institutions which have been reprinted almost without change and without much effort to make them part of a coherent whole. The imperfections of the index render it difficult to refer to any particular point, and the only way to avoid missing important details is to make oneself familiar with the whole book, which is, fortunately, tersely written and by no means long. Difficult as it may be, however, to take full advantage of Mr. James's work, no one concerned in the cyanide process can afford to do without the volume which he has produced.

Index Kewensis Plantarum Phanerogarum. Supplementum primum. By Theophilus Durand et B. Daydon Jackson. Pp. 120. (Brussels).

ON the title-page of this, the first supplement to the "Index Kewensis," the name of Monsieur T. Durand, the director of the botanical garden at Brussels, is associated with that of Mr. Daydon Jackson, the author of the original work. Mr. Durand is mainly responsible for the new part, which deals with species and varieties which have been named during the decade 1886–1895. In order to maintain uniformity, the same arrangement is adopted as in the "Index Kewensis." Most of the new plants are tropical, and quite an appreciable addition is due entirely to Kuntze, who has upset several of the ordinarily accepted genera, though for the most part species names are unchanged. This part takes the genera as far as Cymbidium.

It is hardly necessary to point out the importance of keeping a standard work of this kind up to date, and the author has rendered a great service to systematic botanists in bringing out so quickly, considering the great labour involved, this additional record of plant names.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

The Misuse of Coal.

As England has taught the world how to use coal, she ought to think of teaching the world how to use coal without waste. Coal is so plentiful, so cheap; it is so much to the interest of many people that the waste should go on, and the general public, who alone can apply a remedy, are so ignorant of natural science that when, every few years, I draw attention to this subject, I feel my efforts to be hopeless. Nevertheless, you will perhaps allow me to call attention to the fact that in the very best and largest steam-engines less than 10 per cent. of the energy of coal is utilised; in many small engines only 1 per cent. The remaining energy is quite wasted.

In the electric generating station of a city like Manchester, there are engines of 12,000 horse-power, driving tram-cars and house-lights. In a line of battle ship there is more than twice this power. Two new Cunard steamers are, I understand, about to be ordered, each of which will have 48,000 horse-power. The great waste of energy inevitable in all heat engines of the world is therefore enormous.

It is known that when fuel energy is converted into the electric form directly, as in a voltaic cell, more than 90 per cent. of the fuel energy is convertible into the mechanical form, but at present contrivances to do this even in the case of gaseous fuel are too bulky and expensive to compete with heat engines. I wish once more to suggest that an organised attempt be made to convert the energy of coal into electric energy in some form of engine which shall not cost more or have greater weight than a steam-engine of the same power.

For the heating of buildings, Lord Kelvin pointed out long ago that the very law of thermodynamics which makes a heat-power engine inefficient makes it possible to obtain from one unit of energy the effect of 50 or 100 units by direct heating. I know of nothing which so well illustrates the scriptural promise of the seventy and seven fold reward of virtue as this. Discover the energy engine and you multiply your power to heat buildings from coal, seventy and seven times. But how can we make facts of this kind obvious to ordinary men—the men who are said to be educated when they know absolutely nothing of physical science? Even with coal as cheap as it is we might appeal to its selfish users by pointing out that with the new kind of engine a ship would be able to travel ten times as far at full speed as she now can do without coaling.

The world's yearly output of coal recently was 663 million tons. Of this Britain's share was 30½ per cent. If the whole of the energy of Britain's coal for one year could be utilised and charged for at 8*d*. per Board of Trade unit, the price paid in many towns by consumers of electric energy, it would amount to 100 times our national debt. It is to be remembered that the cost of human labour when used most economically is nine times the figure here given.

Here is another fact. Scientific men know of no other store of energy available for man's use than fuel from the earth, except what we may get by the help of the tides or by wind or waterfalls. To depend upon the future discovery of some great store is to act like a spendthrift who knows of no relation whose death will give him more money and yet who goes on wasting his substance. The energy of coal is the foundation of such widespread comfort as we now observe all over the world. To put the matter in a very definite form we may say:—the cost of one Board of Trade unit of energy by the agency of human labour working most economically is seventy pence; the cost of the unit as given out by a large steam-engine in a cotton factory is one farthing; the cost per unit of the coal alone (at 8*s*. per ton) if all its energy were utilised is one one-hundredth of a penny. But when our coal supply is exhausted, when all the races of the world have fought for the waterfalls and places of high tide, the price must go back to the higher figure. The failure of our coal supply is one of the two things neglected by Mr. Wells in his "Anticipations," the recollection of which would have modified all his conclusions. When coal becomes scarce, people will wonder how it was possible for the nations to spend so much money as they all now do, and our grasshopper weight of a national debt will seem to be an unbelievable burden. Seventy pence to a farthing is the ratio of values without and with coal even now, and the ratio ought to be ten times as great, or 2800 to 1.

In sixty years we have greatly destroyed that store of energy which is the foundation of what some of us call civilisation. In another hundred years the English hamlets of contented working folk that have become cities of luxurious people will decay again into hamlets, inhabited by a discontented, poverty-stricken population which will curse its ancestors for their prodigality. They will not curse us for using coal perhaps, but they will know how to economise coal, and so they will curse us for our ignorance. Over and over again have I called attention to the fact that we are wasting the energy-capital of all the inhabitants of the earth for all time to come. The value of human labour gives the normal value of energy, and at this rate we in England are wasting 900 times the amount of our national debt every year. I have dragged this matter into my lectures and papers with and without relevancy many times, and every one of my hearers and readers neglects its significance. Scientific men know it, but they think it useless to try to impress the ordinary citizen, so ignorant of natural science as he is and so unheeding of any kind of danger which was unknown to his forefathers. What annoys me particularly is not so much the selling of my birthright as that I should sell it for such a mere mess of pottage.

To return to my cry for a new invention. Many men have advanced the subject beyond its first principles; they know of directions in which to work with prospects of success. In the animal machine the thing is actually done; but of this machine

the mere conversion of fuel energy into mechanical work is not the most important function, and the machine is very complex. Still, in it we have no heat engine, but the sort of thing we are looking for. I do not wish to set capitalists and patent lawyers against me, and so I will not give my reasons for saying that there is no sufficient temptation for any scientific man to take up the quest. Unless it is taken up as a matter generally recognised to be of national or world-wide importance, there is no more use in tackling the problem than in hunting De Wet with a small army. Many scientific men must combine their efforts in an organised way, freely communicating their ideas to one another and consulting each other as to their experiments. They must be made free from pecuniary cares and assured of great rewards in case of success. I feel sure that if one or two chiefs like Lord Kelvin or Lord Rayleigh were entrusted with the expenditure of a million a year for two or three years by the English nation for the benefit of the world, with power to impress the services of all scientific workers likely to be of use, to make their operations as extended as they pleased, they would bring the invention within reach of the ordinary engineer.

JOHN PERRY.

Birds attacking Butterflies and Moths.

IT was inevitable that the question of birds attacking butterflies would lead to some account of their attacks upon moths. Although I do not believe that any doubt has been thrown upon the keenness and frequency of the pursuit of moths by birds, a few examples of unusual interest deserve permanent record.

About the year 1887 I saw a fine specimen of the Lobster Moth (*Stauropus fagi*) at rest on the lamp-post at the entrance to Norham Gardens, Oxford. So far as I was aware, it was the first specimen which had been noticed in Oxford, and I was anxious to secure it. The moth was gently touched by a stick tied to an umbrella and came fluttering down feebly towards the ground, when, as I ran to catch it, a sparrow dashed across and seized it before it had reached the ground. I chased the sparrow, encumbered with the heavy moth, for some distance, and at first thought it would relinquish the prize. But it soon flew up to the roof of a house and ate the moth in the rain-water gutter.

I am indebted for the second and very remarkable example to Mr. W. Eagle Clarke, of the Edinburgh Museum of Science and Art. He writes, March 1:—"I send you an account of what I think is a somewhat unusual instance.

"In June last, as I was walking at midday along the road which runs close to the shore of Loch Assynt, in north-west Sutherland, a male Oak Eggar Moth (*L. quercus*) dashed past me with the swift irregular flight characteristic of that species. Suddenly a wheatear, a male, gave chase and, after several failures at capture, succeeded, after a clever but trying pursuit, in securing its prey. The body, &c., of the moth was eaten on the road, where I found the wings, the only remains.

"If I had not seen this 'flight' from start to finish, I should not have thought it possible that a wheatear could have been so swift and smart on the wing, for, as you know, an Oak Eggar is not an easy quarry to secure when in flight.

"I have seen a great titmouse capture the white butterfly—*Pieris rapae*—on the wing."

I am sure that any naturalist who is familiar with the flight of the male Oak Eggar will feel all the astonishment which Mr. Clarke expresses at the success of the bird.

The two remaining examples deal with attacks upon the pupæ of moths.

In July, 1900, Mr. A. H. Hamm, of the Hope Department, showed me a number of cocoons of the Lackey Moth (*C. Neustria*), which had just been opened, probably by sparrows, and the pupæ extracted.

The cocoon is tolerably dense, and is probably still further protected by an abundant sulphur-coloured powder which consists of minute crystals of aragonite (calcium carbonate), secreted by the malpighian tubercles of the larva and extruded from the anus before pupation. The cocoons were spun upon the under sides of leaves of black currant and apple, and it was of the highest interest to observe that every one had been opened by the bird pecking a hole in the leaf from the upper side and thus making an aperture in by far the thinnest part of the cocoon. The observation was made in Mr. Hamm's garden in St. Mary's Road, Cowley Road, Oxford.

The last example is equally interesting, but does not deal with the attacks of birds.

Colonel J. W. Yerbury informs me that when collecting on Beown Mountain, Macgillicuddy Reeks, Kerry, on July 21–22, 1901, he found under a stone, at the height of more than 2000 feet, the old winter store of a mouse or possibly a shrew, consisting of eight to ten cocoons of the Emperor Moth (*Saturnia carpini*). Every cocoon had been gnawed through at the base, viz. the end opposite to that from which the moth emerges, and the pupa extracted.

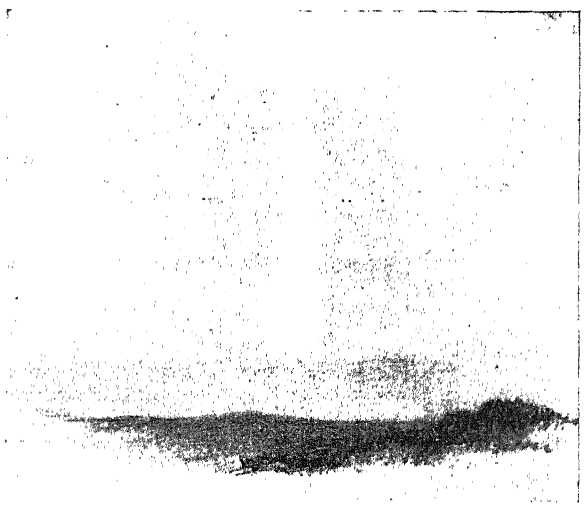
EDWARD B. POULTON.

Oxford, March 6.

Sun Pillars.

ON Thursday the 6th inst. a very fine display of this phenomenon was observed over a considerable area in the west of England, and having regard to Prof. Herschel's interesting letter on the same subject published in NATURE on July 4 last (No. 1653, vol. lxiv. p. 232), perhaps the few facts I have been able to collect may be of interest to some of your readers.

For several days the weather had been exceedingly fine and dry, with hot sunshine and a wind following the sun. The wind on the evening in question had almost died away at sunset; the latter was at 5h. 46m. Greenwich time, and would be about 6h. 5m. here. Close upon 5h. 30m. the light-beam first appeared rising vertically from the sun, which was still visible above a violet-coloured bank of haze; its base did not extend below the sun.



The beam had the appearance of a tall column of very beautiful orange-coloured light brighter in the centre than at the edges; its top must have been quite 20° above the horizon. The sun sank into the haze about 5h. 45m.; the column remained just as bright though reddening gradually until 6h. 20m., and was still distinctly visible at 6h. 40m. It had faded away by 6h. 50m. Faint bands of cloud were visible round the sun, and these sloped from the top of the light-column obliquely downwards in a northerly direction; I also noticed a repetition of the beam on either side of it, though this may have been purely an optical illusion.

I have ascertained that the effect was seen over the whole of Cornwall and Devon, as far east as Salisbury and Taunton, and north as far as Pendine in Carmarthen Bay. Snow has not fallen here for several weeks.

W. H. GRAHAM.

Fowey, March 11.

IN reply to Mr. Knight's inquiry in last week's NATURE (p. 439), he may be referred to many old books, as, for instance, to Moigno's "Répertoire d'Optique Moderne," published in 1847, in the first volume of which he will find a whole section devoted to meteorological optics. The explanation of most of

the phenomena of meteorological optics had, I believe, been worked out by Babinet about ten years earlier.

As to the vertical pillar of light frequently observed in high latitudes after sunset and before sunrise, and occasionally seen in latitudes as low as ours, it may be attributed to spiculæ of ice which, whether isolated or radiating from a centre as in crystals of snow, will assume a horizontal position if they subside through a portion of the atmosphere which is quite free from convection currents. Those of the horizontal spiculæ which are vertically over the cone connecting the spectator's eye and the sun will include some that can directly reflect solar light to his eye, and it is these that produce the phenomenon which was seen by Mr. Knight. The pillar may be expected to be white till the sun gets some distance below the horizon, when it will in succession assume the colours due to the absorption and dispersion of light by the atmosphere.

It can easily be shown experimentally that if the air be free from the minute convection currents which so trouble astronomers (which it seldom is), then subsiding spiculæ of ice will be horizontal. To show this, cut from a sheet of stiff paper a straight, long and narrow strip, and let it fall through the air. The experiment is a pretty one when the strip of paper is thrown out of an upper window on a calm day. The strip falls not lengthwise, but sideways, and spins round its long horizontal axis. The dynamics of this phenomenon have not, I think, as yet been worked out. The explanation would require an investigation of the stream lines surrounding a body rotating as well as progressing through a fluid. It seems to be a problem which might with advantage be proposed to the mathematical research scholars of our Universities.

30 Ledbury Road, W., March 16. G. JOHNSTONE STONEY.

Proofs of Euclid I. 5.

BESIDES the proofs cited by Prof. Bryan (p. 438), another is equally worthy of notice, and requires no construction. The sides of the triangle ABC may be regarded as taken in two orders—

$$\begin{aligned} &\text{AB, AC and } \angle A \\ = &\text{AC, AB and } \angle A \\ \therefore &\angle \text{ opp. AB} = \angle \text{ opp. AC.} \end{aligned}$$

This is a variation of the proof by duplication, but avoids this process. As in the case of the proof cited by Prof. Bryan and involving limiting values, the proof given above is not altogether satisfactory for the use of beginners, and is, of course, of no value to the advancing student except as an interesting illustration of method. H. W. CROOME SMITH.

Bristol, March 15.

As Prof. Bryan is discussing proofs of Euclid's I. 5, may I call attention to the way I proved it in my "Foundations of Geometry," namely as a corollary to the equivalent of I. 4? Thus—

"For if AB in the above proof had been equal to AC, the triangle ABC might also have been moved so that AB fell on DF, and AC on DE, and the triangles would have been congruent so. Hence both the angles ABC and ACB would be shown to be equal to DEF, and therefore to each other."

This seems to me far and away simpler than any other proof I know of, and it has the advantage of directing attention to the fact that the proof of I. 4 as often as not involves turning the triangle over in the air, while moving it; so that, for example, the proof would not apply as it stands to spherical triangles. EDWARD T. DIXON.

Racketts, Hythe, Hants, March 16.

THE NATIONAL PHYSICAL LABORATORY.

SOME further account of the National Physical Laboratory, which is being opened by H.R.H. the Prince of Wales, accompanied by H.R.H. the Princess, as these lines go to press, may be of interest to readers of NATURE. A description of Bushy House, with plans, has already appeared; the alterations required to fit it or a laboratory are now complete, and the new buildings erected for the engineering department are ready or use. The following extracts from the report of the executive committee will indicate what has been done:—

The basement and ground floor of Bushy House have been transformed into a physical laboratory, while the upper floors form offices and a residence for the director. The basement is covered with a brick groining, on which the main building rests, but the more important laboratories are in four large wings, one at each corner, and these have no basement below, thus steady supports are everywhere possible.

One wing, containing the original dining-room and library, has been fitted as an electrical and magnetic laboratory. All iron has been, as far as possible, removed from the structure, and, with a view of preventing a stray magnetic field from any currents which may be used, concentric wiring has been employed for all large currents, while the wires for smaller currents have been twisted.

In this room will be placed the Lorenz apparatus which the Drapers' Company has recently with great generosity given to the Laboratory in memory of the distinguished services to science and to education of the late Principal J. V. Jones, F.R.S., of Cardiff. Along with this there will be other apparatus for the absolute measurement of current and of electromotive force.

Another wing has been fitted for thermometric work. A special study will be made of high-temperature thermometers, and the laboratory owes to the generosity of Sir A. Noble the means for installing a number of electric ovens for testing thermopiles and other instruments for the measurement of temperature up to 1000° or 1200° Centigrade.

In a third wing a metallurgical laboratory has been fitted in which to continue the work begun at the Mint by Sir William Roberts-Austen and the Alloys Research Committee. For this purpose apparatus for cutting and polishing sections and further photomicrographical examination has been obtained. The committee has to thank Mr. Stead for his assistance in arranging this. The fourth wing is fitted as a chemical laboratory. In the basement are a number of constant temperature rooms.

Sir Andrew Noble's fund, referred to in the last report, has provided a measuring machine, a dividing engine and a comparator, which will be placed in some of the basement rooms. In an adjoining room the resistance measurements of the British Association Committee will be continued, while in another, apparatus for the production of liquid air is being set up. The testing of pressure gauges will form an important branch of the work, and for this a mercury column some fifty feet in height has been erected in one corner of the house.

Gas and water have been laid on freely throughout the building—also electricity. A 100-volt circuit is connected to the main dynamo and battery in the power-house, and supplies light. Numerous plug points enable a supply to be taken off for lights for experimental purposes or for small motors. For experimental work a special battery of fifty-five cells has been installed. This is divided into groups of five. Wires run from the switchboard to the various rooms in such a way that one or more of these groups can be switched on to any circuit. Thus voltages between 2 and 110 volts can be obtained as required.

The house is heated on the Webster low-pressure system by steam from a Lancashire boiler in the boiler-house at a distance of about 100 yards. The boiler also supplies steam to one of Parson's 60-kilowatt turbo-generators, which is the main source of power. The power-house also contains an 18-h.p. Crossley gas-engine, driving a 12-kilowatt dynamo by T. Parker and Co. This serves as a stand-by and for charging the main battery of fifty-eight chloride cells.

The engineering laboratory, a building eighty feet by fifty feet, adjoins the power-house. This is divided into two bays; a shaft, driven by a motor supplied by Mather

and Platt, runs along one, and in it will be placed the lathes, drilling machine, planing machine and other tools. The other bay is for experimental work. It is traversed by a 2-ton crane, and will contain a testing machine and machinery for testing steam-pressure gauges, indicators and such instruments.

With regard to gifts to the Laboratory, it has already been mentioned that the Drapers' Company has undertaken to provide the sum of 700*l.* to meet the cost of a Lorenz apparatus, in memory of the late Principal Viriamu Jones. Messrs. Willans and Robinson are providing apparatus for testing steam-pressure gauges and indicators, while in a number of cases very advantageous terms have been granted to the committee by manufacturers of tools and machinery. Lord Rayleigh, Lord Kelvin, Mrs. Hopkinson, and the Syndics of the Cambridge University Press have presented valuable books. Lady Galton has given a valuable astronomical clock with electric contacts, in memory of the late Sir Douglas Galton.

But though much has been done, the Laboratory is far from complete. Rather more than 3000*l.* has been spent on apparatus, but visitors will notice many gaps before the important problems which lie to hand can be fully grasped. Still, it is now possible to make a start, and to show, by the work done with the means at the disposal of the staff, that the Laboratory is fulfilling a need and that it deserves the support of those who are concerned in facilitating the application of science to industry. The pious benefactor, however, who will put it as regards equipment on a footing comparable with the Reichsanstalt is still to seek.

In research work it is hoped that the investigations of the Alloys Research Committee may be continued. Much, though not all, of the apparatus required for this has been purchased; a recording pyrometer, however, must be added to the outfit before it is complete. Prof. Barrett's paper read at the Institution of Electrical Engineers recently showed the importance of the aluminium steels for dynamo and transformer manufactures, and with the kind assistance he then offered it is hoped that a start may soon be made on their investigation.

The measurement of wind pressure is of great importance to engineers; with the help of Sir Benjamin Baker, an investigation will be made into this subject.

In thermometry, the object will be to arrange for the more systematic and ready measurement of the high temperatures met with in industrial undertakings.

As to the commercial testing work which is to be undertaken, the following list will indicate its scope, though until the Laboratory standards have been more thoroughly studied it is hardly possible to do much on a large scale:—

Tests of pressure gauges and steam indicators.

Tests of measuring appliances and gauges for use in engineering shops, &c.

Test of screw gauges.

Tests of thermometers for the measurement of high or low temperature, the platinum thermometer, thermopiles, &c.

Photomicrographic tests on metals, steel rails, &c.

Measurement of the insulation resistance and dielectric capacity of insulators.

Measurement of the electrical resistance of conductors.

Tests of capacity and induction and of various forms of electrical measuring apparatus.

Tests on the magnetic properties of iron, &c.

Standardisation of glass vessels, flasks, burettes, &c., used in chemical laboratories and in various industries—*e.g.* the dairy trade.

Standardisation of weights and scales for laboratory purposes.

Testing of photographic and other lenses.

The director hopes before long to issue a pamphlet giving some account of these various tests, together with a statement of fees charged.

Thus an ample programme has been prepared, and it is interesting to learn on the authority of the director that some slight demand has already shown itself for nearly all the tests enumerated in the list.

PROPOSED ORGANISED RESEARCH ON CANCER.

WE are pleased to learn that a scheme has recently been elaborated in this country for the purpose of systematising and procuring endowment for research upon cancer. In this respect our country is already somewhat behindhand, since a similar organisation has been for some time in full activity in Germany. A large sum of money has been placed at the disposal of Prof. Ehrlich, and a German cancer committee, with Prof. von Leyden as president, is now at work. To this purpose the German Government has already made grants of upwards of 50,000 marks. In America there is a State-subsidised cancer laboratory at the present time, under the direction of Prof. Roswell Park, concerning the work of which some account was given in the *Medical Record* last May. In France, cooperative work upon cancer is also already in progress, a special journal being devoted to the publication of the results.

It will be unnecessary to enter here into the details of the scheme; suffice it to say that any funds will be invested in the names of five trustees, and that the income derived from them will be paid over to a general committee consisting of these trustees and three representatives of the College of Physicians (the president and two censors), three representatives of the College of Surgeons (the president and two vice-presidents), the members of the laboratories committee of the Royal Colleges of Physicians and Surgeons, and one member, to be nominated by the Local Government Board. The general committee will have control of the income of the fund, but concerning the exact method of spending it they will take counsel with an advisory board, which will consist of the laboratories committee of the Royal Colleges and other members chosen in equal numbers by each of the Royal Colleges. It is estimated that the sum of 100,000*l.* will be required for the above purpose. At the present time, funds are conspicuous by their absence.

To the lay mind the term cancer does not imply a well-marked entity; the word is, in fact, occasionally used as synonymous with tumour, meaning, roughly, a swelling or growth where a swelling or growth ought not to be. To the medical mind the term cancer means a special form of tumour which is characterised microscopically by its structure and clinically by its method of growth. This latter is of two kinds, local and general. The local growth consists of an infiltration of the adjacent tissues, the general growth of a dissemination of the particles of the disease which produce growths, conforming in type to the original tumour, in parts of the body more or less remote from the seat of the primary affection. So far as concerns their minute structure, however, tumours growing in the above manner are not all, from the histological standpoint, cancers or carcinomatous. This term has been made by morbid histologists conventionally to designate a definite variety of tumours growing in the above-stated "malignant" manner, viz. those the microscopic structure of which is of the epiblastic or epithelial type. This classification is rendered necessary by the fact that there exists another class of tumours equally malignant, but the minute structure of which is of the connective-tissue or mesoblastic type. These tumours

are termed "sarcomata," a term as meaningless as its congener, carcinoma. We have, then, speaking roughly, two great classes of tumours, the so-called innocent tumours, or those which grow slowly and locally, and the malignant tumours, which grow rapidly and become disseminated all over the body. This latter group, although consisting of two classes, the carcinomata and sarcomata, are generally designated "cancers," and are, no doubt, although, so far as we can ascertain, no specific information is to hand upon the subject, to be the objects of the proposed research.

As very often happens when facts of unmistakable significance are wanting, theories are abundant. This is certainly true of cancer. It must at once be admitted of the theories with regard to the causation of cancer, that although they have no doubt been of great value in assisting what may be termed the crystallisation of histological results, they have, tending as they do rather to express one enigma in terms of another, been of little value from the absolute practical standpoint. Six distinct theories have been put forward concerning the pathogenesis of cancerous growths. Perhaps one of the most generally accepted is Prof. Virchow's theory that these growths are caused by injury or chronic mechanical irritation. There can be no doubt that cancerous growths very frequently affect the parts of the body, either external or internal, which are most frequently subjected to some kind of irritation. Cancer of the tongue in clay-pipe smokers or in the subjects of rough and uneven teeth, cancer of the scrotum in chimney sweeps, due to chronic irritation of the part by soot, &c., cancer of the breast, of the arms in paraffin and tar workers, of the two ends of the stomach, especially apparent in individuals who masticate imperfectly, can all be cited as showing the predilection of cancerous growths to parts of the body exposed to constant or intermittent irritation. Perhaps of all the numerous common factors in cases of cancer, chronic irritation is the most constant. It cannot, however, be regarded as a universal or even adequate explanation of the disease, for, as Cohnheim has pointed out, in 86 per cent. of all the cases irritation apparently plays no part. Prof. Cohnheim regards cancerous growths as being due to the abnormal proliferation of embryonic remnants. He assumes that in the development of the individual from the embryo, more cells are produced than are required for the building up of the organ concerned. There thus remains an embryonic cellular remnant. These embryonic cells remain always possessed of one characteristic of this variety of cell, viz. an unlimited capacity for proliferation. These remnants may remain quiescent, and then nothing more is heard of them; they may, however, under the influence of certain conditions, assume active growth, and may thus constitute malignant tumours. There can be no doubt that this theory explains many of the features of cancerous growths, and is greatly supported by the fact that, speaking generally, new growths are prone to occur in parts of the body which are the seats of complicated embryonic development. We have, however, some actual knowledge of embryonic remnants in the so-called epithelial pearls which are fairly frequently found in the tonsils, and it must be admitted that these organs are rarely the seats of malignant growths. Further, in Cohnheim's theory the actual cause which stimulates the growth of the embryonic remnant is not defined except in the most general terms, viz. as a condition of malnutrition of the surrounding tissue.

The obvious similarity between malignant growths and the so-called infective granulomata has led many observers to the view that the former disease must, like the latter, have a parasitic origin. The analogy between these two classes of affection is perhaps the greatest when we take tuberculosis as the type of the infective malady. Tuberculosis at first local, confined, for instance, to a given part of one organ, produces secondary infection in the adjacent lymphatic glands by means of the lymphatics, and subsequently from these tubercular material may gain entrance into the general circulation, and being carried by it hither and thither may become implanted in the most remotely situated organs and produce tuberculosis of them. In the case of cancer there is, too, always a primary focus which is strictly local, and in this case also the lymphatic vessels carry the carcinomatous material to the adjacent glands and from them either by means of the general lymphatic system or the general circulation, carcinoma of remote organs may ensue. When we come, however, to examine this analogy, we find that it is more apparent than real. Tuberculosis can readily be conveyed from animal to animal; this certainly is not the case with cancer. It is true that examples of what may be termed the auto-inoculation of cancer in man are not uncommon; for instance, in the case of adjacent parts of the body, cancer of the one may spread to the other; this probably simply means that the cancerous tissue of the one organ becomes ingrafted upon the other. This condition is often referred to as "contact cancer." Ebert has collected twenty-three such cases. The actual infectivity of cancer, using this term in the ordinary sense, is at present doubtful, although several instances are recorded of what may perhaps best be expressed by the French term, "cancer a deux." Nineteen such cases are given by Behla; in most instances the persons affected were man and wife. Some instances are also on record of surgeons inoculating themselves accidentally with cancer from the cancers of patients upon whom they were operating.

The similarity between malignant disease and tuberculosis has led numerous investigators to seek for an organism which would bear the same causative relation to cancer as the tubercle bacillus does to tuberculosis. Carcinomata have received more attention at the hands of these investigators than sarcomata. Into the details of these most interesting researches the space at our command forbids us to enter. The main point of difference between the adherents of the parasitic theory of the origin of cancer and their opponents centres upon the significance of certain undoubted microscopic appearances, chiefly of the growing portions, of cancerous growths. Some observers maintain that these microscopical appearances represent an organism of a protozoic type, others regard them as due to degeneration of the cancer cells. The majority, however, of microscopists do not regard the presence of a parasite in cancerous growths as proved. In the case of sarcomata, the parasite is supposed to be, not of animal, but of vegetable origin, probably a torula.

If we turn from the study of the hypothetical cancer parasite to a consideration of the influence of general climatic conditions upon the incidence of cancer, we shall be treading upon more certain ground. The existence of so-called "cancer houses" seems to rest upon very strong evidence. In one instance, six persons within twenty-six years died of cancer in two houses that were under one roof and had a common drainage and water-supply. The inhabitants affected were for the most part unrelated to each other. So intimate appears to be the connection between the existence of cancerous disease and locality that so-called "cancer fields" have been described. These are found in "sheltered and low-lying vales traversed by fully formed and seasonably flooded rivers and composed of the more recent argillaceous formations." Districts, on the other hand, which possess the lowest cancer death rate are generally more or less elevated areas composed of the oldest rocks, especially limestone. The difference between the death rates from cancer in different regions in north Germany

is very marked. In certain neighbourhoods cancerous disease is responsible for one in every hundred deaths, whereas in others one in every thirty-three deaths is due to this cause.

Concerning the—from the public standpoint—most interesting question whether or not cancer is on the increase, there seems to be some difficulty in giving an unequivocal answer. That the mortality statistics show an increase is certain, but increased longevity and increased accuracy of diagnosis are disturbing factors in the drawing of inferences and have led many statisticians to regard this increase as more apparent than real. So far as the United Kingdom is concerned, the class of cancerous disease showing the most marked increase is that of the digestive organs, and this has led to the formulation of hypotheses with regard to the relation between the increase of meat-eating and the increase of cancer. The greatest note of alarm with regard to the future of cancer comes from America. It is estimated that in Buffalo during the last fifty years the death rate from cancer has increased five-fold, and that if this increment is maintained, at no very distant date this disease will be responsible for more deaths than tuberculosis, typhoid fever and small-pox all put together.

From the above paragraphs, which must be regarded rather in the sense of jottings of facts, the interest and the importance of this subject will be evident. It seems, further, that the mere microscopic examination of malignant growths has already yielded up to the observer almost all the information it can do, and that it is in the direction of pathological experiment that new and important truths should be sought for, and will probably be found. With the history of the recent progress of the treatment of zymotic diseases before us, doubtless the factors possibly concerned in cancer immunity will not escape the attention of investigators. It is sincerely to be hoped that the public will respond liberally to the call which is being made upon them for funds to defray the expenses necessarily required for an investigation at once so time-consuming and so important.

F. W. TUNNICLIFFE.

THE OWENS COLLEGE JUBILEE.

THE series of functions at the Owens College, Manchester, last week, in celebration of the jubilee of the foundation of the College, was carried out with complete success. Prof. S. Hickson was master of the ceremonies, and to him, assisted doubtless by the harmonious cooperation of many others, the greatest credit is due.

The programme on March 12 commenced with the opening of the beautiful Whitworth Hall by the Prince of Wales. The Duke of Devonshire, as president of the College, eulogised the high aims and ideals of John Owens, the founder, in eloquent terms. The Prince of Wales urged on the citizens of Manchester not to be content with the magnificent results of the past liberality of such benefactors as Owens, Beyer, Christie, and Whitworth, but to follow them in liberal support and extension of the College. He pointed out that "the work of an institution of this nature must continually expand; and it must not be forgotten that its material resources must also expand as the work grows." He appealed most forcibly to the generous municipal life and patriotism to enable the College "to keep abreast of the ever-growing demands of modern life."

Sir Richard Jebb and Principal Rücker delivered admirable addresses upon the influence which the College has exerted upon progress in literature and science. The ceremony showed convincingly that the Whitworth Hall justified its dignified beauty of design, by conveniences of access and arrangement and most favourable acoustic qualities. The conversazione in the evening afforded the foreign delegates an opportunity of seeing the Manchester Museum, the whole of the Arts and Science Departments, and the new Christie Library opened four years ago.

On March 13 the actual jubilee celebration was held. Nearly one hundred delegates from academies, universities, colleges and learned societies at home and abroad came forward to present the congratulations entrusted to them and to receive the grip of greeting from the president of the College. The principal proposed the vote of thanks to the delegates, and dwelt on the regretted absence from their number, through illness, of his predecessor, Dr. Adolphus Ward, master of Peterhouse, and of Sir Henry Roscoe, to whom the College is deeply indebted in every way. Prof. Harold Dixon, in seconding the motion, confined himself to the followers of his own science, chemistry, and its sister, physics, and noted with pride the attainments of such as were present as delegates.

Earl Spencer, Chancellor of the Victoria University, then took the chair and admitted the distinguished recipients of honorary degrees. The public orators were the principal. Profs. Wilkins, Schuster, Young, Tout, and Lamb, and Dr. Hiles. Prof. Schuster's presentations were notable for their epigrammatic terseness and point; we may cite his presentation of Dr. Glaisher: "His mind was raised to infinite heights by his mathematical genius; it was brought back to earth by his love of the stars."

An informal "physics colloquium" in the laboratory afforded Prof. Becquerel the opportunity of demonstrating some of the remarkable properties of radium and showing by shadow-photographs the analysis of the various kinds of rays it emits. Profs. Voigt and Nernst also gave interesting communications.

In the evening the court, the teaching staff and the delegates dined together in the Whitworth Hall. This function was a private one.

The students who had assisted as spectators on Wednesday and Thursday organised a torchlight procession followed by a smoking concert on Friday evening. Since then the shadows of the terminal examination have fallen on the College.

The following extracts from the complete reports of the ceremony given in the *Manchester Guardian* are of interest:—

The Duke of Devonshire, president of the College, in the course of his opening remarks, said that the idea of the founder was to provide higher education in such branches of learning and science as are usually taught in the English universities. The original idea was thus education of the university type, such as that which had prevailed at the old Universities of Cambridge and Oxford.

The foundation of the College coincided nearly in time with great discoveries in science, and at the same time with inventions which provided the means of using those discoveries for the purpose of industry, and it is these discoveries which have stimulated interest in those studies of natural science in which Owens College has been preeminently distinguished. This is the interest to which, in the main, Owens College has been indebted for its success. Students have no doubt been attracted by the eminence of some of its teachers from all parts of the country, but, in the main, those students have been drawn from Manchester and its immediate neighbourhood. They have come here doubtless with the desire, with the hope, of acquiring knowledge, that knowledge and training which would be of practical use to them in the future occupations of life. But, at the same time, Owens College has never been content to limit the range of its teaching to one or two subjects or one set of subjects. It has never been content to be merely a medical or a legal or a technical college, but it has set before itself the aim of teaching—of a true university type of teaching—which shall embrace all branches of knowledge.

The address from the College to the Prince of Wales was then read by the principal, and in his reply His Royal Highness remarked:—

"On this first jubilee-day of your College the question may be fairly asked whether it has fulfilled the object of the founder. We are told that his idea was to provide, in a great centre of population, commerce and industry, 'higher education in such branches of learning and science as were usually taught in the English universities.' Those who joined with Mr. Owens in this scheme recognised that in the great commercial centres there was both the opportunity for and the need of something in the nature of real university life. Perhaps the best proof of the wisdom of the policy adopted in the case of Owens College is the fact that in nearly all the largest towns of the country there have been founded during the last thirty years colleges to a very large extent on similar lines. Owens College has sent many teachers, not only to these, but to the old Universities of Oxford and Cambridge. And we may also, on this jubilee-day, take stock of those influences which have been instrumental in thus successfully developing and carrying out the original scheme of the founders. Will Owens College ever cease to venerate the names of Owens, Beyer, Christie, Whitworth, and other noble benefactors to whose munificence is chiefly due her creation, endowment and material prosperity? Can she ever be sufficiently grateful to those great teachers and students who have not only by their genius and force of intellect maintained in the College a high standard of learning, but also by their personal example have helped to form the characters and guide the lives of those who have been so fortunate as to come under their influence? Amongst these former eminent leaders, two—Dr. Ward and Sir Henry Roscoe—are, I am sorry to say, prevented by illness from taking part in to-day's ceremony. But great as have been these different forces in building up this vast and important educational machinery, they would not be sufficient without the strength and sustenance which has been secured by local patriotism and local enthusiasm. I feel sure that Owens College may always count with confidence upon a generous local municipal support to enable it to keep abreast of the ever-growing demands of modern life, whether it be in the arts, in science, or other departments of a liberal education."

In connection with the celebration, the honorary degree of D.Sc. was conferred by the Victoria University upon the following distinguished men of science:—Presented by Prof. Young, Dean of the Medical Department: Sir Thomas Barlow, Sir J. S. Burdon Sanderson, Sir W. S. Church, Mr. H. G. Howes and Prof. Simpson. Presented by Prof. Schuster: Prof. Becquerel (Paris), Prof. Chodat (Geneva), Prof. G. Carey Foster, Dr. J. W. L. Glaisher, Principal E. H. Griffiths, Principal Hicks, Dr. E. W. Hobson, Prof. G. B. Howes, Prof. W. Jack, Principal Lodge, Prof. Nernst (Göttingen), Prof. Poynting, Prof. Tilden, Prof. Voigt (Göttingen), and Prof. Marshall Ward. The honorary degree of M.Sc. was conferred upon Mr. C. Bailey, Mr. Francis Jones and Mr. J. H. Reynolds.

CELEBRATION OF THE TWENTY-FIFTH ANNIVERSARY OF THE JOHNS HOPKINS UNIVERSITY.

THE twenty-fifth anniversary of the foundation of the Johns Hopkins University was celebrated at Baltimore last month. The commemorative address delivered by Dr. D.C. Gilman, for twenty-five years president of the University, and now president of the Carnegie Institution, is published in *Science*, together with the address delivered by Prof. Remsen upon his inauguration as president of the University. The assembly was one of the most noteworthy that has been gathered together in America, being composed of leaders in many branches of intellectual activity. In the course of the ceremonies an address, signed by more than one thousand alumni of the university and others, was presented to Dr. Gilman. We give extracts from the addresses delivered by Dr. Gilman and Prof. Remsen.

In the course of his address Dr. Gilman said:—

When this university began, it was a common complaint, still uttered in many places, that the ablest teachers were absorbed in routine and were forced to spend their strength in the discipline of tyros, so that they had no time for carrying forward their studies or for adding to human knowledge. Here the position was taken at the outset that the chief professors should have ample time to carry on the higher work for which they had shown themselves qualified, and also that younger men, as they have evidence of uncommon qualities, should likewise be encouraged to devote themselves to study. Even those who were candidates for degrees were taught what was meant by profitable investigation. They were shown how to discover the limits of the known; how to extend, even by minute accretions, the realm of knowledge; how to cooperate with other men in the prosecution of inquiry; and how to record in exact language, and on the printed page, the results attained. Investigation has thus been among us the duty of every leading professor, and he has been the guide and inspirer of fellows and pupils, whose work may not bear his name, but whose results are truly products of the inspiration and guidance which he has truly bestowed.

The biological laboratory, the first establishment of its kind in the United States, has carried forward for many years the study of marine life at various points on the Atlantic and has published many important memoirs, while it has trained many able investigators now at work in every part of the land. Experimental psychology was here introduced. Bacteriology early found a home among us. The contributions to chemistry have been numerous and important. Here was the cradle of saccharine, that wisely diffused and invaluable concentration of sweetness, whose manufacturers unfortunately do not acknowledge the source to which it is due. In the physical laboratory, light has been thrown upon three fundamental subjects—the mechanical equivalent of heat, the exact value of the standard ohm, and the elucidation of the nature of the solar spectrum. For many years this place was the chief seat in this country for pure and advanced mathematics.

I cannot sit down without bringing to your minds the memories of those who have been with us and have gone out from us to be seen no more: Sylvester, that profound thinker devoted to abstractions, the illustrious geometer whose seven prolific years were spent among us and who gave an impulse to mathematical researches in every part of this country; Morris, the Oxford graduate, the well-trained classicist, devout, learned, enthusiastic and helpful, most of all in the education of the young; accomplished Martin, who brought to this country new methods of physiological inquiry, led the way in the elucidation of many problems of profound importance, and trained up those who have carried his methods to every part of the land; Adams, suggestive, industrious, inspiring, versatile, beneficent, who promoted, as none had done before, systematic studies of the civil, ecclesiastical and educational resources of this country; and Rowland, cut down like Adams in his prime, honoured in every land, peer of the greatest physicists of our day, never to be forgotten in the history of physical science. I remind you also of the early student of mathematics, Thomas Craig, and of George Huntington Williams, the geologist, whose memory is cherished with admiration and love. Nor do I forget those who have here been trained to become leaders in their various departments throughout the country. One must be named, who has gone from their number, Keeler, the gifted astronomer, who died as the chief of the Lick Observatory in California, whose contributions to astronomical science place him among the foremost investigators of our day; and another, the martyr Lazear, who, in order that the pestilence of yellow fever might be subdued, gave up his life for humanity.

Prof. Remsen chiefly dealt in his address with the development of the university idea in America, and showed that the noteworthy characteristic of educational work in recent years is the philosophical faculty in the universities and the surprisingly rapid increase in the attendance upon the courses in such faculties. He remarked:—

In 1850 there were 8 graduate students in all the colleges of America. Of these, 3 were enrolled at Harvard, 3 at Yale, 1 at the University of Virginia and 1 at Trinity College. In 1875 the number had increased to 399. In 1900 the number was 5668. At present the number cannot be far from 6000.

In order that these facts may be properly interpreted, we should know how many Americans are studying in foreign

universities. The records show that in 1835 there were 4 American students in the philosophical faculties of German universities; in 1860 there were 77; in 1880, 173; in 1891, 446; in 1892, 383; in 1895, 422; and in 1898, 397.

These figures show clearly that the increase in the attendance at American universities is not accounted for by a falling off in attendance at German universities. On the other hand, they do show that for the last ten years at least there has been no increase in the attendance at German universities, but rather a slight decrease.

Six thousand students are, then, to-day pursuing advanced courses in American universities, while not longer ago than 1875 the number was only about 400. In this connection it must further be borne in mind that during this period the colleges have not relaxed in their requirements. The tendency has been in the opposite direction. So that it means to-day more rather than less than it did in 1875 to be a graduate student. That there is an increasing demand for university work is clear, and it seems to be destined to play a more and more important part in the development of educational methods.

University work is not something apart, independent of other kinds of educational work. It is a necessary part of the whole system. It affects not only the colleges, but schools of all grades, and must, therefore, have a profound influence upon the intellectual condition of the whole country.

But the universities are also doing another kind of work of importance to the country. Through their specially prepared men they are doing something to enlarge the bounds of knowledge. To be sure, such work is also being done to some extent in colleges and elsewhere, but the true home of the investigator is the university. This work of investigation is as important as the work of training men. What does it mean? All persons with healthy minds appear to agree that the world is advancing and improving. We see evidences of this on every side. Those results that appeal most strongly to mankind are, perhaps, the practical discoveries that contribute so much to the health and comfort of mankind. These are so familiar that they need not be recounted here. If great advances are being made in the field of electricity, in the field of medicine, in the field of applied chemistry, it is well to remember that the work that lies at the foundation of these advances has been done almost exclusively in the universities. It would be interesting to trace the history of some of these advances. We should find that in nearly every case the beginning can be found in some university workshop where an enthusiastic professor has spent his time prying into the secrets of nature. Rarely does the discoverer reap the tangible reward of his work—that is to say, he does not get rich—but what of it? He has his reward, and it is at least a fair question whether his reward is not higher than any that could be computed in dollars and cents.

The material value to the world of the work carried on in the university laboratories cannot be over-estimated. New industries are constantly springing up on the basis of such work. A direct connection has been shown to exist between the industrial condition of a country and the attitude of the country towards university work. It is generally accepted that the principal reason why Germany occupies such a high position in certain branches of industry, especially those founded upon chemistry, is that the universities of Germany have fostered the work of investigation more than those of any other country. That great thinker and investigator, Liebig, succeeded during the last century in impressing upon the minds of his countrymen the importance of encouraging investigations in the universities, and since that time the German laboratories of chemistry have been the leaders of the world. In Germany the chemical industries have grown to immense, almost inconceivable, proportions. Meanwhile the corresponding industries of Great Britain have steadily declined.

What I want to make clear is that universities are not luxuries, to be enjoyed or not, as we may please. They are necessities. Their work lies at the very foundation of national well-being.

The best thing we can do for our students is to give them good professors. Sumptuous laboratories, large collections of books and apparatus, extensive museums are well enough. They are necessary, no doubt. But I fear they are too much emphasised before the public. A university is, or ought to be, a body of well-trained, intelligent, industrious, productive teachers of high character provided with the means of doing their best work for their students, and therefore for the world.

NOTES.

PROF. WINOGRADSKY, of St. Petersburg, has been elected a correspondant of the Paris Academy of Sciences, in the Section of Rural Economy.

THE seventy-fourth meeting of the German Association of Naturalists and Physicians is this year to be held on Austrian soil, Carlsbad being the town selected, and the date September 21 to 27. The arrangements will be generally the same as those introduced at Hamburg last year, but it has been decided to add a new division to the medical group—the history of medicine—so that the scientific side will be represented by eleven divisions, as before, and the medical by seventeen.

THE following are among the lecture arrangements at the Royal Institution, after Easter:—Dr. Allan Macfadyen, three lectures on recent methods and results in biological inquiry; Prof. Karl Pearson, three lectures on the laws of heredity, with special reference to man; Prof. Dewar, three lectures on the oxygen group of elements; and Dr. A. Smith Woodward, three lectures on recent geological discoveries. The Friday evening meetings will commence on April 11, when Prof. Dewar will deliver a discourse on problems of the atmosphere. Succeeding Friday evening discourses will be delivered by Dr. J. Mackenzie Davidson, Sir Robert Ball, Sir Benjamin Baker, Mr. A. E. Tutton, and other gentlemen.

WE regret to see the announcement of the death of Sir Richard Temple, Bart., M.P., F.R.S., whose personality was well known in scientific and educational circles. He was vice-chairman of the School Board of London for three years from 1885 and afterwards chairman of the finance committee of the Board. He was also president of the Social Science Congress held at Huddersfield, and the author of several works on Indian and Eastern topics.

THE death is announced of Mr. Robert Pendlebury, fellow of St. John's College, Cambridge, and well known by his mathematical work. Mr. Pendlebury graduated in the mathematical tripos of 1870 as senior wrangler. He also graduated at the University of London, obtaining the senior University scholarship for mathematics and natural philosophy. He was in due course elected to a fellowship at St. John's, and for many years was one of the college lecturers in mathematics. He was also University lecturer in mathematics, but recently resigned all his appointments. He had been an examiner for the mathematical tripos on several occasions, and for some time a member of the Special Board for Mathematics.

WE learn from the *Victorian Naturalist* that the Central Australian expedition under the leadership of Prof. Baldwin Spencer and Mr. F. J. Gillen reached the Macarthur River, Northern Territory, but was detained at Borroloola, a small township about 50 miles from the mouth of the river, owing to the foundering of the steamer which should have taken them on to Port Darwin as previously arranged. The matter of affording the expedition some relief was brought before the Commonwealth Parliament without result. However, the Premier of Victoria (Hon. A. J. Peacock) placed himself in communication with the Queensland Government, and it was arranged to send a small steamer from Normanton and bring the party on to that port, from whence there is frequent communication with eastern Australia.

IT is announced in the *Times* that the two Royal medals of the Royal Geographical Society have been awarded to Sir F. D. Lugard, for his African explorations and surveys, and to Major Molesworth Sykes, for his journeys in Persia, extending over nine years, and his valuable studies of the geography of the country. The other awards of the society have been made

as follows:—The Murchison grant to Mr. J. Stanley Gardiner, for his researches in Funafuti Island in the Pacific and the Maldive Islands in the Indian Ocean; the Gill memorial to Mr. G. G. Chisholm, for the services he has rendered during twenty-five years to geographical education by text-books of various kinds, atlases and lectures, all of a high standard of value, as well as for his geographical investigations, among other subjects into cataracts and waterfalls, and on the sites of towns; the Back grant to Lieut. Amdrup, of the Danish navy, for his two voyages of exploration to the east coast of Greenland, during which he surveyed and mapped in detail much of the coast hitherto unknown or imperfectly mapped; the Peek award to Mr. J. P. Thomson, the founder of the Queensland branch of the Australian Geographical Society, who, by his writings and in other ways, has done much to promote the interests of geography in Queensland.

THE Naples Academy (mathematical and physical section) has awarded the prize for natural sciences for 1901 to Dr. Marussia Bakunin, the authoress of six printed papers dealing with stereochemistry. The subject announced for the next award (entries closing June 30, 1903) is the formation of urea in the animal organism.

THE prize awards of the Reale Istituto Lombardo for the year 1901 are as follows:—Triennial medals to Prof. Giuseppe Sartori, of Brescia, for preparation of butter with acidified cream, and to Pietro Gamberini, of Milan, for photographic apparatus. Under the Brambilla foundation, a gold medal and 1000 lire to the Società del Laminatojo di Malavedo for the production of soft steel, a similar award to Franchi e Griffin for the wheels of tempered iron (suitable for tramcars and other rolling stock) made by the Griffin process, and a gold medal and 500 lire to Turrinelli and Company for their introduction into Milan of a service of public automobiles worked by electricity. A Fossati foundation award of 1000 lire to Dr. Carlo Martinotti, of Turin, for his macro- and micro-scopic researches on the encephalus of the higher animals. Pizzamiglio foundation prizes of 1500 lire to Dr. Alfredo Piazzi, of the University of Turin, and of 750 lire to Dr. Guido Jona, of Savona, for essays on secondary education. Under the Tommasoni foundation, for studies of the life and works of Leonardo da Vinci, awards of 1000 lire to each of the three competitors, comprising Dr. N. S. Scognamiglio, Prof. G. B. de Toni and Edmondo Solmi.

THE number of the *Rendiconti* of the Lombardy Institution containing the announcements of prize awards also gives a list of future subjects for prizes. Of the prizes of the Institution, that for the present year (entries closing March 31, 3 p.m.) is for a toponomastic exploration of some district of Lombardy; that for 1903 is for some original contribution to our knowledge of the theory of transformation-groups as founded more particularly by Liè. The two triennial medals for 1903 will be offered, as usual, for improvements in the agriculture and in the manufacturing industries in Lombardy. For the Cagnola prizes, the subjects selected by the Institution are, for 1902 (entries closing April 1), the study of the effects of the gases emanating from various manufactories on the growth of cultivated plants, and for 1903, a monographic study of hypophysis. The four subjects selected by the founder for the remaining Cagnola prizes deal with the the cure of pellagra, the nature of miasma and contagion, aërial navigation, and the prevention of forgery, and in connection with the second subject it is suggested in a footnote that competitors might deal with prophylactic measures against malaria considered in connection with our present knowledge of the biology and mode of diffusion of the microbe of this disease. The Brambilla prize is offered for improvements in the manufactories of Lombardy. The Fossati prize for 1902 is for macro- and micro-scopic researches on the encephalus of the higher animals, for 1903 on the nuclei of origin or termination of the cranial nerves, and for 1904 on the localisation of certain cerebral centres. The Kramer prize, confined to Italian engineers, is offered for a report on systems of electric traction. The Secco-Comneno prize is for a description of the Italian natural phosphatic deposits and their practical uses (entries closing April 30, 3 p.m.). A prize is offered under the Pizzamiglio foundation to Italians for an unpublished manuscript on the influence of modern socialistic doctrines on private rights. Ciani prizes are offered for popular Italian literary works, a triennial Zanetti prize (entries closing March 31) is offered to an Italian pharmaceutical chemist who shall obtain a result which is considered of use in the progress of pharmaceutical and medical chemistry, and a Tommasoni prize for 1905 for a study of the life and works of Leonardo da Vinci.

THE thirteenth session of the International Congress of Americanists will be held in the American Museum of Natural History, New York City, October 20-25. The object of the Congress is to bring together students of the archæology, ethnology and early history of the two Americas, and by the reading of papers and by discussions to advance knowledge of these subjects. Communications may be oral or written, and in French, German, Spanish, Italian or English. The papers presented to the Congress will, on the approval of the Bureau, be printed in the volume of the *Proceedings*. The subjects to be discussed by the Congress relate to:—(1) The native races of America, their origin, distribution, history, physical characteristics, language, inventions, customs and religions; (2) the history of the early contact between America and the Old World. All persons interested in the study of the archæology, ethnology and early history of the two Americas may become members of the Congress by signifying their desire to Mr. Marshall Saville, general secretary of the Commission of Organisation, American Museum of Natural History, New York, and remitting either direct to the treasurer (Mr. Harlan I. Smith, American Museum of Natural History) or through the general secretary, the subscription of three dollars. Mr. Morris K. Jesup is president and the Duke of Loubat vice-president of the Commission of Organisation.

THE Government Report of the Committee on Acetylene Generators, which has just been issued by H.M. Chief Inspector of Explosives, shows that the acetylene industry has attained a position of no little importance. Consisting of some thirty pages, the Report, which is the outcome of the work of a strong committee, contains some valuable tabulated results of tests on forty-six specified generators, showing their gas production, efficiency, and maximum pressure in the generating chamber and in other parts of the plant. It speaks very highly for the industry that every one of these generators sent in for examination has been reported by the Committee to be satisfactory. We share the opinion of the Committee that many of the generators on the market are too complex in construction, and when prime cost, space, loss of water and of gas by solution are not important considerations, we agree with the view that the non-automatic generator, on account of its certainty and simplicity, is to be preferred to the automatic type. A list of what the Committee consider the conditions which a generator should fulfil in order to be considered safe should be of great value to those engaged in the design of acetylene plant. The only thing to which exception may be taken is a limit of five inches water pressure suggested for the gas in the service mains; by raising this limit to six or seven inches, the possibilities of using the gas for heating purposes would be greatly increased, and, as we believe that it is generally admitted that under pressures of less than two atmospheres there is no danger of spontaneous decomposition, such an increase does not seem

objectionable, though a three to four inch limit might be imposed for lighting purposes alone. We should like to have seen some remarks upon the purification of the gas and the ventilation of buildings in which it is used in an unpurified condition. Two-thirds of the Report is devoted to the description, with many illustrations, of the types of generators tested. This is valuable as a summary of the catalogues of various makers, but we wish the Committee had seen its way to make some criticisms upon these various types, as was done some time ago by those responsible for the exhibition of generators which was held at the Imperial Institute.

AN advance proof of a Parliamentary paper, received from the Home Office, shows that the total output of coal of the United Kingdom in the year 1901 amounted to 219,037,240 tons, as compared with 225,170,163 tons in the preceding year. The outputs of some other minerals were as follows, the numbers representing tons:—copper ore and copper precipitate, 6792; iron ore, 1,671,025; ironstone (worked under Coal Mines Regulation Acts), 6,849,926; lead ore, 32,552; rock salt, 151,348; tin ore (dressed), 6542; zinc ore, 23,582.

PROF. HERDMAN has written to Mr. I. C. Thompson to say that his investigation of the pearl fisheries of the Gulf of Manaar is being greatly facilitated by everyone interested in it at Ceylon. A steamer—the *Lady Havelock*, of three hundred tons—has been chartered, and a start was made at the end of January. Dr. A. J. Chalmers has given Prof. Herdman the use of a room in his laboratory at Colombo, and Mr. J. C. Willis has offered a work place in his laboratory at the magnificent Botanic Gardens at Peradeniya. Prof. Herdman adds:—"I found up country at Anurhadapura (one of the 'buried cities' of Ceylon) the two Germans, Dr. Paul and Dr. Fritz Sarasin, who have been exploring for years in Ceylon, and were the only people who could give me information about Trincomalee, where I wish to dredge. Finally, I met Prof. Alex. Agassiz, just returned from his expedition to the Maldive archipelago, and he kindly lent me 600 fathoms of especially strong and flexible steel rope, which will be a valuable addition to our tackle. Prof. Agassiz, you will be interested to hear, says he has had a most successful trip, and has secured all the information, photographs and specimens of the coral reefs that he desired. He says the Maldives are the last of the great coral archipelagoes which he had set before himself to examine, and that now he is prepared to write his book on the general subject, 'Coral Reefs and Islands.' There can be no doubt that he has a much more extended personal knowledge of the reefs of the world than Darwin, Murray, or any other previous writer."

AN interesting description of an experimental locomotive appears in the *Times* of March 12. The boiler is an entire departure from ordinary practice; in fact, it may be called a water-tube boiler applied to the locomotive. To Mr. Dugald Drummond, of the London and South-Western Railway, is due the credit for this innovation, and it will be interesting to watch its development. Mr. Drummond has long experimented with water-tubes in the fire-box of the ordinary locomotive with much success, a system originally patented by Mr. W. S. Smith, of the North-Eastern Railway. The modified boiler consists of an ordinary locomotive boiler shell and an ordinary shaped fire-box, but in place of the large number of tubes usually used, one large flue-tube is fitted and this contains many water-tubes; there are also water-tubes in the fire-box. It will, therefore, be seen that the products of combustion on their way from the fire-box to the smoke-box must pass through the large flue-tube and encounter the many water-tubes in it. The locomotive fitted with this boiler has been working the west country expresses between Waterloo and Salisbury with gratifying results. Steam is stated to be maintained with ease. The coal consumption recorded with a train of twelve carriages was under 29 lbs. per mile; it would have been more satisfactory, however, had the weight of the train been stated, because the consumption is decidedly low. This type of boiler should be of much use on locomotives of the ten-wheeled description. The excessive length of ordinary tubes required in this class is out of all proportion, from a heating-surface point of view, such engines having tubes nearly 16 feet long and only 2 inches in diameter, whereas with Mr. Drummond's new boiler a long barrel would be a decided advantage. It is evident that very perfect combustion is possible; the gases are well mixed in the large flue and the flame is less likely to be extinguished on its way to the smoke-box.

A PAPER by Mr. T. R. Rao on the Yánádis of the Nellore district, Madras Presidency, appears in the *Bulletin* (vol. iv. No. 2) of the Madras Government Museum, from which the accompanying illustration of a method of making fire has been reproduced. To produce fire by friction in this way, the Adivi or forest Yánádis prepare two sticks—one short, the other long. In the former a square cavity is made, and it is held firmly on the ground, while the long stick is twirled rapidly to and fro in the hole. No charcoal powder is used, but a rag, or even dried leaves, are ignited. The Yánádis possess the characteristics of jungle tribes, and are little removed from savagery, the culture being that of the Palæolithic stage. This is indicated by the absence of implemental or monumental material, the animistic, and to some extent zoo-theistic, nature of the religion, the primitive hunting and fishing methods followed by many of the tribe, and the habit of eating the almost raw flesh of the game they kill, after slightly heating or scorching it. The Yánádis are fearless in catching cobras, which they draw out of their holes without any fear of their fangs. They appear to protect themselves against the effects of snake-bite by swallowing the poison sacs of snakes.

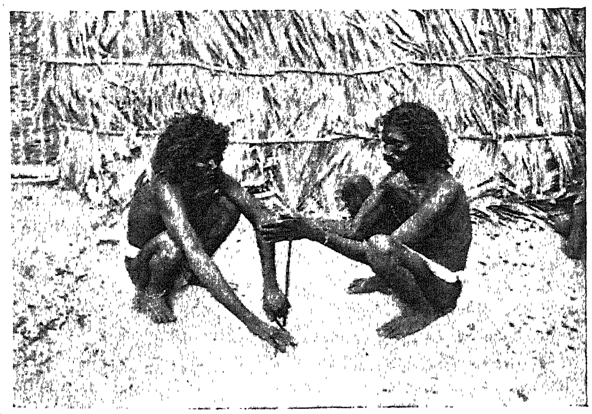


FIG. 1.—Yánádis making Fire.

IN a paper entitled "Environment in Relation to Sex in Human Culture" in the *Popular Science Monthly* for January, Dr. Otis T. Mason gives a series of notes on the main characteristics of the chief cultural areas of America which will be useful to those who desire to obtain a general survey of aboriginal American sociology.

IN the *American Anthropologist* (n.s. vol. iii. p. 737), Dr. G. A. Dorsey describes the recent progress in anthropology at the Field Columbian Museum in Chicago. Thanks to an energetic and efficient staff and the enlightened liberality of Chicago merchants, this museum is fast assuming a place in the

front rank of the great anthropological museums of the world. This record by Dr. Dorsey is enough to make us feel ashamed of ourselves in this country, as it is only a sample of what is being done in other American museums and institutions.

THE most interesting article to the general reader in the current number of the *Bulletins et Mémoires de la Société d'Anthropologie* (v. sér. tome 2) is one by M. C. Lejeune on the representation of sex in religion, art and education. A paper on the normal and varietal myology of the fox appears out of place in an anthropological journal. Various reproductions are given by M. E. Rivière of the mural paintings of animals from the cave of La Mouthe, similar to those to which we have recently directed attention (p. 299). It will be remembered that M. Rivière was the first to discover these paintings. A paper by M. G. Cauderlier on the causes of the depopulation of France gave rise to an interesting discussion.

IN the *Bulletin* issued by the Botanical Department at Trinidad and edited by Mr. Hart, under the heading of "Root Irritation," reference is made to the difficulty of planting out young mangosteens, cloves, or Palmyra palms. If the seeds have been started in pots, when transferred to the open ground the young plants have a strong tendency to die off. It is suggested that this may be due to the tender nature of the roots or root hairs, which seem to suffer if they are disarranged or carelessly handled in the process of transplanting. In the case of the mangosteen this question has a most important bearing, for the life of the seed is so fugitive that it becomes necessary to start the seed in pots if plants are to be forwarded to a distance; then besides the necessity for keeping the plant in good growing condition on the journey, there is the added danger of losing it when it is transplanted. Another extract from the same paper refers to the slow and irregular germination of balata seeds (*Mimusops globosa*), which may take any period from three months to two years. These seeds have a hard exterior which takes up water slowly, so that germination would probably be accelerated by piercing the seeds before sowing.

A SMALL pamphlet issued by the Indiana Agricultural Experiment Station deals with two plant pests, the horse nettle and the buffalo bur, both specimens of Solanum. The former, *Solanum Caroliniense*, has travelled north from the county after which it has been named. Propagation is effected by underground shoots and also by seed. While it is easy to prevent the plant seeding, shoot propagation is not so easily checked. Ploughing cuts up the shoots, and then each portion may develop independently. Constant hoeing, however, provides a remedy, as by continual cutting the propagative power is finally exhausted; or the plant may be smothered by sowing rape or barley or other quick-growing crops. The buffalo bur, *Solanum rostratum*, has a spiny stem and fruit. It is a typical xerophyte from the south-west, from the counties of Texas and Nebraska. It seems to have been carried eastward as an impurity with other seeds. Being an annual it is more easily strangled, although it has an illicit habit of throwing up short fruiting branches if it is cut near the surface of the ground.

AMONG several interesting biological articles in the *Sitzungsberichte* of the Bohemian Scientific Society for 1901, one by Dr. J. V. Rohon on the anatomy and histology of the Devonian dermal plates and spines described as Psammosteus is of special importance. It was pointed out by Agassiz and Pander that the histological structure of these spines seemed to indicate affinity with the sharks; and Reis concluded that both Psammosteus and Pteraspis were degenerate selachians. This view is not accepted by the author, who regards both these groups of armour-clad Devonian fishes as specialised types, indicating two nearly related families. In Dr. Smith Woodward's "Catalogue of Fossil Fishes in the British Museum" the systematic position of Psammosteus was left undetermined, although some countenance was given to the theory of its selachian affinity. To the same serial Mr. J. Palacký contributes an article on the distribution of edentates and another on that of bats.

IN the *Aarbog* of the Bergen Museum for 1901, Mr. O. Nordgaard gives the results of his investigations as to the food of the coal-fish (*Gadus virens*) at different portions of its existence. From the stomachs of young individuals the author took no less than thirty distinct kinds of organisms. From this it appears that during the first year of its existence this cod subsists chiefly upon plankton. Generally this fare is sufficient, but if it fail the fish resorts to sea-weeds, where it feeds upon various minute crustaceans, young molluscs and even hydroid polyps. From the stomach of one individual were taken no less than 6250 copepod crustaceans—representing the average fauna of about 20 cubic yards of water. The stomachs of older coal-fish contained herrings, sprats, the salmonoid Mallotus, sand-eels, the cephalopod Ommatostrephes, and various crustaceans, among them Boreophausia. It is further proved that coal-fish prey on their own offspring as well as on those of the cod. In the northern fjords of Norway, where very large catches of coal-fish are sometimes made (34,000 head in the autumn of 1898), the great shoals appear to be brought together by their pursuit of herrings and Ommatostrephes. In December and January, however, a great influx of spawning coal-fish reaches the western coast of Norway.

WE have received a copy of the extremely interesting and suggestive presidential address on "The Nature of Disease," delivered by Sir T. N. Fitzgerald before Section H of the Australasian Association at Hobart in January last. After referring to the importance of sanitation, the president of the section dwelt on the evidence in favour of the hereditary nature of neurotic affections, and—in contrast to this—the comparative rarity with which deformities and malformations are inherited. In this connection he deprecated the common prejudice against the marriage of cousins, which he regarded in many respects as specially suitable. Physical diseases, other than syphilis, are also regarded as non-hereditary; and the theory of the transmissibility of many of them by infection is strongly supported. Consequently, the author of the address is greatly in favour of the isolation and notification of phthisis. In treating of the intrinsic causes of disease, emphasis was laid on the part played by bacilli, and some interesting observations are added in reference to the readiness with which the bacillary hypothesis was received by the medical profession almost as soon as it was propounded. In reference to the harm caused by alcoholism, the following sentences are worthy of quotation:—"The bicycle, I venture to say, has done more to elevate the people in the matter of temperance than a week of lectures have been able to effect. It is in this direction, then, in my opinion, that philanthropists should work. I have lived too long not to recognise 'the dullness of the lives of the masses,' and how productive of evil this lack of variety must be."

THE fifth volume of the new edition of Thompson's "Gardener's Assistant," edited by Mr. William Watson, has been published by the Gresham Publishing Company. When the sixth (and last) volume has appeared, the complete work will be reviewed.

THERE is only one opinion among men of science as to the necessity for spreading abroad the gospel of scientific truth and righteousness taught by Huxley. A sixpenny edition of a selection of his "Lectures and Essays," just published by Messrs. Macmillan and Co. in conjunction with the Rationalistic Press Association, should do much to cultivate this

desirable interest in science and philosophy. The contents include lectures on evolution and the physical basis of life, and essays on aspects of agnosticism and ecclesiasticism which may lead incipient rationalists to firm ideas "on the nature, the duties and the non-insoluble problems of human life."

A COPY of Hazell's Annual for 1902, edited by Mr. W. Palmer, was received a few days ago from the publishers, Messrs. Hazell, Watson and Viney, Ltd. The annual is so well known and widely used that little need be said as to the character of the contents. Certainly no better epitome of the subjects which attracted general attention during last year is available; and no manual can be better depended upon to give concise and accurate information concerning public men and affairs and national interests. Among the subjects of new articles in the present edition we notice anthropology, archæology, astronomy, biology, chemistry, electricity, geography, geology, meteorological office, motor vehicles, photography, telephones and universal time. Under each of these headings a short account is given of progress made during last year. These summaries are naturally of very little value to the student of science, but they serve to give general readers a view of some of the results attained. Under biology, less than a dozen subjects are mentioned—all of them zoological—and there is no reference to botany either under this heading or elsewhere in the book. Other subjects we miss are physics, metallography (to which a paragraph might well have been devoted), radiations from radium and similar substances, malaria and mosquitoes. In the list of educational associations we find the usual secondary school organisations, but not the Association of Technical Institutions, to which practically all the principals of our technical school belong.

THE overproduction of alcohol, a consequence of the overproduction of sugar, has led to many attempts to increase its use for purposes of lighting and heating. In contrast to the repressive action of our own authorities in this matter, the strangling action of which in our chemical industries is well known, M. Jean Dupuy, the French Minister of Agriculture, organised a conference in December last to discuss the best means of extending the use of denatured alcohol for lighting and heating. The current number of the *Bulletin de la Société d'Encouragement pour l'Industrie Nationale* contains a report of this conference by M. Lindet, and gives a complete account of the numerous forms of alcohol burners which have been devised both for lighting and heating. In conclusion, M. Lindet discusses the question as to the cost of heating and lighting by alcohol in comparison with the methods in current use, and especially with reference to petroleum, and points out that although petroleum has a slight advantage in the matter of cost, this is more than counterbalanced for domestic purposes by the cleanliness and freedom from smell of the alcohol.

THE same number of the *Bulletin* contains an interesting review, by M. Ach. Livache, of the methods in use for the destruction or utilisation of town refuse. The processes in use fall mostly under two types, incineration, which has been chiefly developed in this country, and treatment by reduction, in which either a solvent or superheated steam is used. The latter is mostly in favour in the United States. The relative advantages of the two methods are critically examined, it being pointed out that no hard and fast rule can be laid down which will be applicable to all cases, a careful examination and analysis of the refuse which it is proposed to treat being an indispensable preliminary.

THE additions to the Zoological Society's Gardens during the past week include a Green Monkey (*Cercopithecus callitrichus*) from West Africa, presented by Mrs. A. Clayton; a Common Otter (*Lutra vulgaris*) British, presented by Mr. W. H. Radcliffe Saunders; a Naked-footed Owlet (*Athene noctua*) European, presented by Mrs. Tewson; a Larger Hill Mynah (*Gracula intermedia*) from Northern India, presented by Miss F. V. Cooper; a Mute Swan (*Cygnus olor*) European, presented by Mr. R. S. Lindley; a South African Ground Hornbill (*Bucorvus cafer*) from Zululand, presented by Major C. H. Rowley, D.S.O.; three Lions (*Felis leo*) from South-west Africa; a Malayan Bear (*Ursus malayanus*) from Malacca; a Bennett's Cassowary (*Casuarius bennetti*) from New Britain, deposited; two Common Rheas (*Rhea americana*) from South America; a Sœmmerring's Pheasant (*Phasianus soemmerringi*) from Japan; twelve Goldeneyes (*Clangula glaucion*) European, purchased.

OUR ASTRONOMICAL COLUMN.

NEBULA AROUND NOVA PERSEI.—A circular from the Centralstelle at Kiel announces the receipt of an interesting communication from Prof. Max Wolf concerning the changes in the nebulous surroundings of Nova Persei. On March 5 he obtained a fine photograph with an exposure of four hours, which showed that all the former condensations had become weaker. From the Nova towards the south-west there now extends a new long zone of nebulosity much brighter than the previously existing condensations. Indeed on February 3, the date of the last previous photograph, this region was very bright. It is extremely interesting that this later nebulosity is brighter than the appearance of August, 1901. The same circular also announces a communication from the Lick Observatory stating that from recent photographs with the Crossley reflector Perrine finds no evidence of polarisation in condensations A and D of the Nova Persei nebula.

NEW VARIABLE STAR, 3, 1902 (MONOCEROTIS).—Prof. W. Ceraski, of Moscow, announces the variability of the star B.D. + 6°·1462,

$$\left.\begin{array}{l}\text{R.A.} = 6\text{h. } 50\text{m. } 37\text{s.}\cdot 4\\ \text{Decl.} = +6^\circ\ 21'\cdot 4\end{array}\right\}(1855\cdot 0).$$

The star was near maximum about February 20, being then about 7·0 mag. The determination was photographic, but there is not sufficient data yet available to calculate the period. The magnitude in the B.D. is 8·0 (*Astronomische Nachrichten*, Bd. 158, No. 3775).

SEISMOLOGY IN AUSTRIA.

AT the present time the shelves of libraries throughout the world are bending beneath volumes of statistics, the analysis of which it is hoped will lead to the discovery of something new. To these piles of undigested materials, if we surmise correctly, there is shortly to be added an inundation of statistics from those who study earthquakes. Twenty years ago, seismologists were few and far between, but now they have increased in number and are represented by organised societies, which publish journals and reports. The first of these had its origin in Japan. Fifteen years later a corresponding body appeared in Italy, following on the heels of which came commissions and committees with similar objects in various European countries. Even the time-honoured routine of many meteorological and magnetical observatories has not been allowed to rest in peace, and the daily round at these establishments includes a visit to the seismographs.

As illustrative of these new departures, we call attention to what is being done by the Royal Academy of Sciences in Vienna. In 1895 this body established a Commission for the Observation of Earthquakes, the reports of which were published in the Academy's *Transactions*. Possibly on account of their size they are now issued as separate numbers, twenty-one of which form the first series. Of the second series six parts have been issued, a brief notice of which will give an idea of the extensive and valuable investigations now being carried out in Austria.

The key to this work is found in part ii. of the series, which its author, Dr. E. v. Mojsisovics, describes as a general report of shocks recorded in Austria in the year 1900. From this

we learn that the number of earthquakes was 169 as against 190 noted in 1899 and 209 noted in 1898. To obtain these records the empire has been divided into sixteen districts, each district having its referee. Dalmatia, for example, has 423 observers, who send their observations—unfortunately for the editor—in at least three different languages, to Prof. A. Belar in Laibach.

There are five horizontal pendulum stations, four of which receive from the Government a yearly subvention of 1000 to 1100 K. A sixth station is to be installed at Pribram, one instrument to be on the surface and another at a depth of 1100 m. in the Adalbert-Schacht.

In part i. Dr. W. Láska gives a catalogue of records obtained between June 1899 and December 1900 from a three-component seismograph installed at Lemberg. From the introduction to this work it is clear that Dr. Láska has met with troubles, some of which might certainly have been avoided had he been acquainted with the experiences of his predecessors. On the second page we learn that the clock employed to drive the record-receiving photographic film has also been employed to give time marks on the same. To expect a time-piece to unroll a heavy band of paper or to turn a drum and at the same time to keep a chronometer-like rate is a false economy in which those who construct seismographs for the first time frequently indulge. Whatever inaccuracies may, in consequence of this apparent simplicity of arrangement, have crept into Dr. Láska's time determinations it was evidently his intention that what could be measured should be measured with unimpeachable exactitude. The writer has in his possession a globe which, as it could not be made in England, was purchased from abroad. Its scale is stated to be 1/25,823,716·814. Although Dr. Láska does not aim at such exactitude, he tells us that the mirror of his N.W. pendulum is 3·757 m. distant from the recording drum, whilst the period of the pendulum when hung vertically is $0^{s}\cdot31515$, to which, however, he adds that there is no certainty about the accuracy of the fourth decimal. Tables which inform us that 0·1 minute = 6 seconds, 0·2 minute = 12 seconds, &c., also convey an idea of unnecessary redundancy.

In the working of the instrument, which is installed in a cellar, a well-known bogie has been encountered. There is hardly a seismologist who has not met it, and volumes sufficiently numerous to form a moderate library have been published describing its behaviour. It is a something which causes pendulums to move fitfully, and many observers cling to the belief that it is an actual motion of the ground and either trace the same to the beating of waves on a distant shore or to some other cause. The photograms showing these movements which Dr. Láska reproduces are strikingly like those obtained from observatories all over the world. Forasmuch as a copious ventilation or the burning of a gas jet in the room thus haunted frequently results in expelling the intruders, my own opinion is that the majority of them have their origin in the movements of the atmosphere in the room rather than the movement of the ground.

To show that there may be a relationship between seismic disturbances and the movements of magnetic needles which is not mechanical, our attention is once more drawn to the ancient story of the magnet at Parc St. Maur which at the time of an earthquake was caused to move whilst a similarly formed and similarly suspended copper bar remained at rest. Our attention, however, is not drawn to the possibility that these two systems had very different natural periods of vibration.

In a supplement, suggestions are made respecting the determination of the distance of an earthquake origin from a given station from the interval which elapses at that station between the arrival of the preliminary tremors and the large waves. In recent reports issued by the British Association, especially that for 1900, it will be seen that not only have these suggestions already assumed a practical form, but also that other subjects referred to by Dr. Láska have received greater or less consideration.

Part iii. is a detailed account of earthquakes noted in German Bohemia by Dr. V. Uhlig.

In part iv. Prof. P. Franz Schwab gives the records obtained from an "Ehlert" pendulum installed at Kremsmünster. From an analysis of the records it appears that the frequency of earthquakes was much less between Apogee and Perigee than between Perigee and Apogee. In the cooler months, especially from the middle of September to the beginning of March, the pendulums were frequently unsteady. The greatest disturbances, however, accompanied marked barometric depressions. These movements probably eclipsed movements due to earthquakes.

The next number, by Dr. E. Mazelle, is a register of 146 records obtained from a Reubeur-Ehlert pendulum at Trieste.

One excellent suggestion made by Dr. Mazelle is that seismologists should have a uniform system in chronicling their observations.

The periods of his pendulums are taken monthly and are recorded to within 1/100 of a second of time, whilst a table is given to compute possible tiltings of the pendulum to within 1/1000 of a second of arc.

At the end of this paper we find certain analyses of the registers, relating, for example, to the monthly frequency and the frequency of disturbances of different amplitudes, those with amplitudes between 1 and 2 mm. forming 35 per cent. of the total observations.

The sixth part of these publications, by J. N. Woldrich, refers to the earthquake which on January 10, 1901, shook north-east Bohemia. Here and there we find reference to unusual phenomena like the swaying of forests as if moved by a strong wind, the increase or decrease of water in springs, and the effect of the movements upon men and the lower animals. The latter, excepting the story of a man who by the shaking was caused to walk in his sleep, are of the usual type.

Most of these papers are accompanied by maps or diagrams.

J. M.

SCIENTIFIC SERIAL.

THE February number of the *Journal of Botany* contains three articles dealing with mosses. The first and most interesting paper records the finding of an Arctic species, *Tetraplodon Wormskioldii*—practically a Splachnum—on Widdy Bank Fell, by Messrs. E. C. Horrell and D. A. Jones. Its usual habitat is about 70° N., and further north.—Mr. Duncan discusses the occurrence of *Octodiceras Julianum* along with Fontinalis in the River Severn.—There is the first part of a joint paper by Messrs. D. Prain and E. Baker on Indigofera species, in which it is proposed to deal with the numerous synonyms.—Mr. C. B. Clarke writes an appreciative article on Colonel Sir Henry Collett, who combined botany with various important administrative posts in India.

IN the number for March, Messrs. S. Schönland and E. G. Baker conclude a series of articles on South African species of Cotyledon.—Two sets of "Notes" deal with the distribution of plants. The first, by C. E. Salmon, enumerates floral localities in Norfolk, thereby furnishing an appendix to Trimmer's "Norfolk Flora" and the supplement thereto.—The second article, written by William Whitwell, relates to East Sussex. He alludes to the "Notes" given by Salmon in the last December number of this journal, which were more copious and referred to the whole county. These two papers, with Arnold's well-known book, should bring the Sussex flora up to date, more especially since Mr. Salmon benefited by help from Mr. Botting Hemsley and by records due to Mr. Roper.—In the supplement, Mr. Batters once again essays a catalogue of British marine Algæ, which will be very cordially welcomed. The "revised list" was published in the *Annals of Botany*, 1890, by the same writer in conjunction with Mr. Holmes. As regards localities a change will be noticed; instead of the arbitrary sections of the coast given in the revised list, specific towns, &c., are now mentioned. Practically the whole of this part deals with the Myxophyceæ, or, as they are generally termed, the Cyanophyceæ.

SOCIETIES AND ACADEMIES.

LONDON.

Physical Society, March 14.—Mr. S. Lupton, vice-president, in the chair.—A paper on the thermal expansion of porcelain was read by Mr. A. E. Tutton. The paper gives an account of experiments made to determine the expansion of Bayeux porcelain between 0° and 120° C. The material employed was a portion of the tube used by Bedford in his experiments on the expansion of porcelain between 0° and 830° C. Another piece of the same tube has also been used by Chappuis in a series of determinations by the Fizeau method between 0° and 83° C. The author has worked with an interference dilatometer, which possesses advantages over the Abbe

form of the original Fizeau apparatus. The observing part of the instrument is separated from the expansion chamber, and the temperature of the interference tripod and the substance under investigation, which it carries, is measured by means of a thermometer bent just above the cylindrical bulb and so arranged that the latter lies on the tripod table. The chief advantages over the Fizeau apparatus are briefly, (1) the employment of a micrometric method of measuring the position and width of the interference bands; (2) the use of autocollimation; (3) the employment of C hydrogen light; (4) an arrangement of the thermal chamber which readily permits an extension of the range to 120° C. The author has also introduced an aluminium compensator, a relatively thick disc of aluminium laid on the top of the porcelain tube. This overcomes the difficulty of polishing the porcelain and affords a large field of bands instead of an annular ring showing parts of bands. The mean of three determinations with three specimens of material gives the following result for the linear expansion, $L_t = L_0[1 + 10^{-9}(2522t + 7{\cdot}43t^2)]$. The results presented by the author agree tolerably well with those of Chappuis, but the constant a is slightly smaller. The constant b is seven times larger than according to Bedford. The discrepancies between the results of Chappuis and Bedford appear to be due to a fundamental real difference, dependent on the interval of temperature for which the determinations were made. The increment per degree of the coefficient of expansion of porcelain is not a constant quantity, but one which is much larger between 0° and 100° than at higher temperatures. The supposition of Prof. Callendar, as to the anomalous expansion between 0° and 100°, appears to be well founded.—The secretary then read a paper by Mr. W. Williams on the temperature variation of the electrical resistances of pure metals and allied matters. In the first part of the paper an attempt is made to correlate the periodic variations which pure metals exhibit as regards their atomic weights, chemical valencies, melting points and electric resistances. If m is the chemical valency, V the atomic volume, θ the absolute temperature, T the absolute melting point and c, or $V^{\frac{1}{3}}\alpha T$, the constant of Pictet's law, then $\sigma \propto \frac{mV\theta}{cT}$, where σ is the specific resistance at 0° C. This relation holds for most of the metals, but fails for gold, indium, tin and aluminium, and also for metals of the iron group. The temperature resistance-coefficients of pure metals are not equal to 1/273, and an expression for the change of resistance with temperature has been deduced which holds approximately for many metals. The author also obtains simple expressions for the average increment per degree of the specific heat of metals and for the ratio between the specific resistances of the solid and liquid states of a metal at the temperature of fusion.—A paper entitled "A suspected case of electrical resonance of minute metal particles for light waves; a new type of absorption," by Prof. R. W. Wood, was read by the secretary. Experiments on which the author has been engaged have led him to believe that he has found a new type of light absorption, which it may be possible to refer to the electrical resonance of small metallic particles for waves of light. Metallic deposits on glass have been produced which are shown by the microscope to consist of particles less than the wave-length of light, and which by transmitted light exhibit colours as brilliant as those produced by aniline dyes. The author has sought to explain these colours by interference and diffraction, and has been forced to accept the hypothesis suggested in the title of the paper. The metallic deposits can be obtained by heating small fragments of the alkali metals in exhausted glass bulbs, when the vapour condenses on the cold parts of the bulbs and forms the films. It can be shown that the colours are due to the presence of metallic sodium (in the case in which sodium has been used) by allowing air to enter the bulb; oxidation takes place and the film vanishes. In some experiments the air has been allowed to enter very slowly, and the changes which the film undergoes before it vanishes have been examined. The particles which form the deposits can be classed under three heads: (1) coarse particles which diffract or scatter light and give the bulb a silky lustre; (2) minute particles very close together which regularly reflect those wave-lengths absent in the transmitted light, but give no scattered light; and (3) minute particles far apart which diffuse light of the same wave-lengths as those which are to some extent absent from the transmitted light. By observing the spectrum of the transmitted light, the author has examined the changes in colour which accompany changes in temperature of the films. The paper gives an account of the relation between the colour of the film and the size and distribution of the particles, and also of the behaviour of the films with polarised light. Experiments upon the electric resistance of the films have proved that they are non-conducting. The author concludes by stating that at the present stage it is impossible to decide either in favour of, or against, the theory of resonance. The idea of resonance has proved a useful working hypothesis for explaining some of the phenomena described in the paper. The secretary read a letter from Prof. R. Threlfall directing the attention of the author to some experiments upon the same subject published by him in 1894.

Chemical Society, March 6.—Dr. E. Divers, F.R.S., vice-president, in the chair.—The slow oxidation of methane at low temperatures, by Dr. Bone and Mr. R. V. Wheeler. Much controversial matter has been published on this subject, the point in dispute being which of the two constituents of marsh gas, viz. carbon and hydrogen, undergoes oxidation first when the gas is burned in an insufficient supply of oxygen. The authors find that methane between 300° and 400° C. burns simultaneously to carbon monoxide and water, small quantities of carbon dioxide being also formed, probably as the result of a secondary reaction.—Isomeric additive compounds of dibenzyl ketone and deoxybenzoin with benzal-*p*-toluidine, *m*-nitrobenzalaniline and benzal-*m*-nitraniline, iii., by Dr. F. E. Francis.—These additive compounds exist in three modifications, differing in melting point and other physical properties, and are thus easily separable one from another.—Mesoxalic semi-aldehyde, by Messrs. Fenton, F.R.S., and Ryffel. When tartaric acid is treated with gaseous chlorine in presence of ferrous salts it undergoes oxidation, forming the semi-aldehyde of mesoxalic acid, which can be isolated in the form of its osazone and dioxime.—The action of hydrogen peroxide on carbohydrates in presence of ferrous salts, by Messrs. Morell and Crofts. In this reaction, glucose, mannose, lævulose and arabinose are oxidised to their corresponding osones.—*m*-Nitrobenzoyl camphor, by Dr. M. O. Forster and Miss F. M. G. Micklethwait. This substance has been prepared by the action of nitric acid on benzoyl camphor. The most interesting feature exhibited by it is that it only exists in the enolic form, whilst benzoyl camphor occurs in both ketonic and enolic modifications, camphor itself being only known in the ketonic form.—The Cloëz reaction, by Dr. Chattaway and Mr. J. M. Wadmore. When cyanogen chloride or bromide reacts with sodium ethoxide, urethane and triethylcyanurate are formed. This reaction is, at first sight, inexplicable if the formula C:N.Cl be assigned to cyanogen chloride, but the authors suggest that the latter reacts first with the alcohol, forming an ethyl iminochlorocarbonate, which in secondary changes gives rise to the products mentioned above.—The picrimidothiocarbonic esters, by Mr. J. C. Crocker. The author describes the products obtained when picryl chloride reacts with ammonium thiocyanate.—Robinin, violoquercitrin, myrticolorin and osyritrin, by Mr. A. G. Perkin. The author finds that myrticolorin, a quercetin glucoside, is identical with osyritrin.—The nitration of *sym.* trihalogen anilines, by Dr. Orton. When the aniline operated upon contains a bromine atom in the para-positions relative to the amino-group, it is replaced by a nitro-group. The similar chlorine substituted anilines do not undergo this replacement.—Some *sym.* nitrochlorobromanilines and their derivatives, by Dr. Orton. A description of the products obtained in the course of the foregoing investigations.—The resolution of pheno-α-aminoheptamethylene into its optical merides, by Prof. F. S. Kipping, F.R.S., and Mr. A. E. Hunter. This base undergoes de-racemisation when it is converted into the racemic *d*-tartrate and the latter is fractionally crystallised from water containing tartaric acid.

Linnean Society, February 20.—The Rev. T. R. R. Stebbing, F.R.S., in the chair.—On behalf of Mr. G. M. Thomson, of Dunedin, N.Z., the secretary exhibited a series of photographs of New Zealand flowers. In connection with the plants, some observations were made on the birds which visit them, *e.g.* the bell-bird or "korimako," *Anthornis melanura*, the grey warbler, *Gerygone flavirostris*, the pied fantail, *Rhipidura flabellifera*, and the yellow-breasted tit, *Petroeca macrocephala*. Of these, the first-named was observed to assist in the fertilisation of the native fuchsias, on quitting which the feathers of the head were seen to be stained with the bright

blue pollen of the flowers. A favourite nesting-site of the tit, *Petroeca macrocephala*, was said to be immediately under the head of the ti-tree, *Cordyline australis*, a good photograph of which was likewise exhibited.—A paper was read by Dr. J. E. Duerden on the internal structure and histology of *Bunodeopsis globulifera*, Verrill, a West-Indian sea anemone, which he had previously described as new (in a paper on the Jamaica Actiniaria published in 1898) although without bestowing any specific name. Prof. Verrill had since described it under the name *Bunodeopsis globulifera*, but his description was limited to an account of the external characters. Dr. Duerden now described in detail the peculiarities of its anatomy and minute structure.—Mr. B. Daydon Jackson, in a report on the botanical publications of the United Kingdom as a part of the "International Catalogue of Scientific Literature," gave the history of botanic bibliography from the time of Linnæus, mentioning the admirable catalogue by Dryander of Sir Joseph Banks's library and passing on to the Royal Society's "Catalogue of Scientific Papers," at present consisting of eleven volumes, ranging from 1800–1883, the last seventeen years being in course of compilation. The genesis of the "International Catalogue of Scientific Literature" was then briefly described and the means adopted for the collection and classification of titles given. The Linnean Society had contributed the titles of papers and books issued within the United Kingdom, amounting to about 2300, and the first part of the volume devoted to botany for 1901 was now in the hands of the printers for early publication.—A paper by Miss Lettice Digby was read on her behalf by Mr. J. E. S. Moore, on the structure and affinities of some Gastropoda from Lake Tanganyika belonging to the genera Chytra and Limnotrochus, the paper being based on material which formed part of Mr. Moore's African collections. The external features, nervous system and viscera were described in detail and the affinities of the species considered.

Zoological Society, March 4.—Mr. William Bateson, F.R.S., vice-president, in the chair.—Mr. E. N. Buxton gave an account, illustrated by lantern slides, of his recent sporting-expedition to the Egyptian Soudan, in the course of which he traversed the route along the White Nile between Khartoum and Fashoda. Mr. Buxton exhibited a series of photographs of mammals and birds taken from living specimens. Among these were views of the white-eared kob (*Cobus leucotis*) and the tiang (*Damaliscus tiang*).—Dr. H. Lyster Jameson read a paper on the origin of pearls. The author's observations referred especially to *Mytilus edulis*, the common mussel. The pearls were found to be due to the presence of parasitic Distomid larvæ, which entered the subcutaneous tissues of the mussel and became surrounded with an epidermal sack similar in its characters to the outer shell-secreting epithelium of the mantle. If the Distoma died in the sack it became calcified, and formed the nucleus of a pearl, the pearl arising, like the shell itself, from the calcification of the cuticle of the epithelial cells. The parasite sometimes migrated out of the sack, in which case the nucleus of the pearl was inconspicuous. Dr. Jameson had investigated the life-history of this parasite, and found that it arose as a tailless Cercarian larva, in sporocysts, in *Tapes decussatus* and *Cardium edule*. He had succeeded in infecting mussels from Tapes in an aquarium. The adult stage of this parasite was apparently *Distoma somatinae*, Levinsen, which occurs in the intestine of the eider duck, and which the author had found in the scoter or black duck (*Œdemia nigra*). The complicated life-history of the parasite, and the absence of organs of locomotion in the Cercaria-stage, sufficed to account for the anomalous and hitherto inexplicable distribution of pearl-bearing mussels. Dr. Jameson had found that pearls were caused by similar parasites in several other species of Mollusca, including some of the pearl-oysters; and he believed that the artificial infection of the pearl-oysters could be effected in a similar manner to that which he had found successful in the case of the common mussel. When this was achieved the problem of artificially producing pearls would be solved.—Dr. P. L. Sclater enumerated the species of parrots of which specimens were contained at the present time in the Society's collection—109 in all—and made remarks on some of the rarer species.—Mr. G. T. Bethune-Baker read a paper entitled "A Revision of the Amblypodian Group of Butterflies of the Family Lycænidæ." The author was of opinion that the whole of the species of this group could be conveniently relegated to six genera—viz., Amblypodia, Iraota, Surendra, Thaduka, Mahathala and Arhopala—and that it was useless to split up the genera further, as had been attempted by some entomologists.—A communication from Mr. Martin Jacoby contained the descriptions of sixty-three new species of Coleoptera of the family Halticidæ from Central and South America.

Geological Society, February 26.—Prof. Charles Lapworth, F.R.S., president, in the chair.—On some gaps in the Lias, by Mr. Edwin A. Walford. The author's endeavour is to prove gaps in the stratigraphical succession of the Lias, involving the removal of zones or parts of zones, and also to prove palæontological gaps by the abrupt appearance of many new genera of Mollusca.—On the origin of the river-system of South Wales, and its connection with that of the Severn and Thames, by Mr. Aubrey Strahan. The southerly courses of some rivers from the Usk to the Ogmore are described, and shown to be independent of both the east-and-west folding and the north-north-westerly faulting of the rocks on which they lie. Farther west the drainage-system takes a different direction, the rivers coinciding so closely with a set of west-south-westerly disturbances as obviously to have been determined in direction by them. Of the three systems of disturbance alluded to, the east-and-west (Armorican) folding was pre-Triassic; it marks a period of compression with impulse from the south, and though it reached great intensity in Devon, Somerset and South Wales, it died away in Central Wales. The north-north-westerly (Charnian) faulting, though partly of pre-Triassic age, was renewed in post-Eocene times, and is manifested over much of the British Isles. It marked periods of relief from pressure, and of subsidence. The west-south-westerly (Caledonian) folding was the latest; it marked a period of compression, with impulse from the north, and displayed greater energy in Central than in South Wales. It gave rise to a series of subsidiary disturbances in the latter region, and initiated and controlled the river-system. The ignoring by the rivers of the structures due to the earlier disturbances is attributed to the Palæozoic areas having been overspread by Upper Cretaceous rocks at the time of the initiation of the river-system. The eastward course of the Upper Severn is attributed to the upheaval of a main axis (now the main water-parting) in Central Wales. Its deflection to the south and south-west was due to the formation of an anticline in the Chalk, which must have been parallel to, but a little west of, the present Chalk-escarpment, and which was parallel to, and contemporaneous with, the Caledonian disturbances in Wales. This anticline, acting in combination with the Armorican folding displayed in the London and Hampshire basins, initiated the systems of the Thames and Frome. Those systems were initiated in post-Oligocene and pre-Pliocene times, and the same age is inferred for the systems of South Wales and of the Severn.

MANCHESTER.

Literary and Philosophical Society, February 18.—Mr. Charles Bailey, president, in the chair.—Mr. R. L. Taylor read a paper on a modification of Rose's method of separating cobalt and nickel. In the original process described by Mr. Rose and improved by Mr. T. H. Henry, barium carbonate and chlorine (or bromine) were added to rather strongly acid dilute solutions of the two metals and allowed to stand, with frequent shaking, for from twelve to eighteen hours. The cobalt was precipitated as sesquioxide, while the nickel remained in solution. Mr. Taylor finds that if a neutral solution is used, the precipitation of the cobalt is complete in a few minutes, and that excellent quantitative results can be obtained. The retardation of the reaction which occurs when the solution is (as Rose and Henry used it) strongly acid at the outset, the author shows, is due to the free carbonic acid which is produced in the solution when the carbonate is added to the acid liquid. A similar retardation occurs in a neutral solution if carbon dioxide is first bubbled through it or if soda-water is added to it. Mr. Taylor recommends the process for the separation and detection of cobalt and nickel in the ordinary process of qualitative analysis. Either barium or calcium carbonate may be used (dry, precipitated, as usually sold, will do) with bromine water, and if no free acid is present at the outset, the cobalt is all precipitated in five minutes. On filtering, nickel can be readily detected in the filtrate by adding a little ammonia and ammonium sulphide. If there is any free acid present at the outset, it must either be boiled away or neutralised before adding the carbonate. Sodium carbonate may be used for neutralising, but then the free carbonic acid must all be boiled away, and the liquid cooled, before adding the carbonate and bromine water.—Mr.

D. L. Chapman described some experiments which have been carried out, in conjunction with Mr. F. A. Lidbury, principally for the purpose of discovering whether Faraday's law may be considered as applying to gases. The electric discharge was passed through water vapour, and the separation of oxygen and hydrogen which took place was found to be from two to three times as great as that which occurred in a voltameter placed in the same circuit. The results are, therefore, inconsistent with the view that the phenomenon is essentially electrolytic.

February 25.—Mr. C. Bailey, president, in the chair.—Dr. Henry Wilde, F.R.S., delivered the Wilde lecture, his subject being "The Evolution of the Mental Faculties in Relation to some Fundamental Principles of Motion."

DUBLIN.

Royal Irish Academy, February 24.—Prof. R. Atkinson, president, in the chair.—Prof. F. T. Trouton read for Prof. W. Ramsay, F.R.S., a paper on the molecular surface energy of some mixtures of liquids. The liquids with which the determinations were made were mixtures of carbon bisulphide and chloroform, ethylene dibromide and chlorobenzene, toluene and acetic acid, ethylene dibromide and acetic acid, ethyl alcohol and benzene, ethyl alcohol and chloroform. Mixtures in proportions varying by about 10 per cent. each step were prepared and the surface tension determined in each case at several temperatures. From these it was sought to adduce information as to the state of molecular aggregation in the mixtures by calculating the mean molecular weight in each case given by assuming that the relation $\gamma(Mv)^{\frac{2}{3}} = k\tau$ holds good for mixtures. These determinations are given in the paper in the form of tables.—Prof. John Joly, F.R.S., read a paper on solvent denudation in fresh water and sea water." The experiments are comparative: on basalt, orthoclase, obsidian and hornblende. It is found that the rate of solvent denudation unaccompanied by attrition in sea water is very much faster than in fresh water, contrary to what is generally inferred from the experiments of Daubrée.

EDINBURGH.

Royal Society, February 3.—Lord M'Laren in the chair.—Mr. James Russell read a paper on magnetic shielding in hollow iron cylinders, the magnetising force being transverse to the axis of the cylinder. The field within the cylinder was measured inductively by means of a rotating coil in connection with a ballistic galvanometer. Two different iron cylinders were experimented with, and the cylinder could, if desired, be magnetised circularly by means of a coil wound round it parallel to the generating lines. The general conclusions are as follows:—(1) When no other magnetising force is acting than that due to the transverse field increasing by increments from zero, the shielding ratio diminished by unity is proportional to the ratio permeability (B/H) and not to the differential permeability (dB/dH). In descending fields the theoretic conditions are not fulfilled. (2) When a circular magnetising force is acting upon the iron cylinder in addition to that due to the transverse field, the order and manner in which the one field is superposed upon the other affects the shielding ratio to an enormous extent, and the conclusions arrived at are not in harmony with the investigations of Stefan and Du Bois (see *Electrician*, vol. xl. p. 654, 1898). When the circular magnetisation is superposed upon a pre-existing magnetisation due to the transverse field, the shielding ratio diminished by unity is proportional to the differential permeability as impressed upon the iron by the circular field. It attains a maximum for comparatively low values of this field and then falls off towards an asymptotic minimum. When the circular field is applied first, the shielding ratio becomes distinctly reduced in value, and becomes still further reduced if the transverse field is subjected to repeated reversal. On the other hand, repeated reversal of the superposed circular field increases the shielding ratio so long as the values of dB/dH are high. The paper contained many other results of interest. Prof. Schäfer, in a note on the existence within the liver cells of channels which can be directly injected from the blood-vessels, referred to the recent work of the Drs. Fraser and Dr. Browicz, and then drew attention to the fact that in one of the slides in the possession of the physiology department of the Edinburgh University the existence of these channels was clearly indicated. The slide was prepared in 1886 for Prof. Rutherford by Dr. (now Prof.) Carlier, but though Dr. Carlier drew Prof. Rutherford's attention to it at the time, no further notice was taken of it.—Dr. D. F. Harris, in a paper on functional inertia a property of protoplasm, contended that functional or metabolic inertia is that property of living matter in virtue of which it tends to remain in the functional *status quo ante*. It is of two kinds, katabolic and anabolic, according as it is katabolism or metabolism that persists in spite of stimuli tending to alter the metabolic phase. It was shown to express itself under very different categories — biochemical as "latent period," "refractory period" (physiological insusceptibility), as rhythm, or as accompanied by consciousness. Thus functional inertia is the physiological counterpart or antithesis of irritability or affectability. Its recognition as a property of protoplasm enables us to correlate a very large number of different phenomena of both animal and vegetable life having apparently nothing else in common.—In a paper on functional inertia of plant protoplasm, Mr. R. A. Robertson gave further illustrations of Dr. Harris's views. The phenomena of latent periods in stimulation by gravity, heat, contact, injury, are expressions of the anabolic phase of the inertia; those of the periods of activity after inhibitory stimulation—as when protoplasmic movement is inhibited by high temperature, sunlight, or absence of oxygen, assimilation by cold, desiccation or darkness, growth in length by light, &c.—indicate the katabolic phase of inertia. Functional inertia finds expression in the existence of stimulatory limits, periodicity of growth and movement, and in the phenomena of polarity, and so on. It appears as a physiological insusceptibility in photochemical induction and elsewhere. In virtue of it protoplasm can be educated and new characters acquired. Its time value varies from a few seconds to hours and may be artificially extended to days; its amount may be infinite in respect of a single stimulus of any degree of intensity, but relatively small (as in the case of a dry seed) for a combination of simultaneously acting stimuli.

PARIS.

Academy of Sciences, March 10.—M. Bouquet de la Grye in the chair.—Preparation and properties of a new hydride of silicon, by MM. H. Moissan and S. Smiles. Magnesium silicide having approximately the composition $SiMg_2$ was treated with dilute hydrochloric acid, and the escaping gas, which was spontaneously inflammable and consisted largely of hydrogen, passed through a U-tube cooled down to the temperature of liquid air. A solid substance separated out in the cooled tube, which partially boiled off on allowing the temperature to rise. The volatile portion was found to be ordinary hydrogen silicide, SiH_4, the remaining liquid, which boiled at 52° C., proving to be a new compound of the composition Si_2H_6, analogous to ethane. The most remarkable property of this new compound is that of catching fire spontaneously in the presence of air at the ordinary temperature, and if a small quantity of the liquid is introduced into a large volume of hydrogen, the latter also acquires the property of becoming spontaneously inflammable in air.—The conditions of vegetation of vineyards giving high yields, by M. A. Müntz. By systematic analyses of the soil, manure added, and the amount of sugar produced in the grape, the author has been able to correlate the amounts of nitrogen, phosphoric acid and potash used in the production of one kilogram of alcohol from the fermented grapes. It is found that vines giving high yields require larger amounts of fertilising materials, but that the latter do not increase in proportion to the amounts of sugar elaborated.—On the extension of the theorem of Lagrange to viscous fluids, by M. P. Duhem.—On glycosuria due to asphyxia, by MM. R. Lépine and Boulud.—M. Winogradsky was nominated a correspondant in the section of rural economy in the place of the late M. Demontzey.—Observations of the sun made at the Observatory of Lyons with the Brunner 16 cm. equatorial during the third quarter of 1901, by M. J. Guillaume. The results are expressed in three tables, showing the number of spots, the distribution of the spots in latitude and the distribution of faculæ in latitude respectively.—A theorem on trigonometrical series, by M. H. Lebesgue.—On factorial series, by M. J. C. Kluyver.—On the cohesion of liquids, by MM. Leduc and Sacerdote. A new interpretation is given of an old experiment in which the weight required to pull away a plane glass surface from a liquid is regarded as a measure of the cohesion of the liquid. In reality the cohesion of the liquid has nothing to do with the effect.—The electromagnetic theory of the aurora borealis and the variation and perturbations of terrestrial magnetism, by M. Charles Nordmann. It has been shown that there is a close relation between the spectrum of the aurora and

that of the light round the kathode of a tube containing oxygen or nitrogen. The author concludes that the aurora borealis is a kathode phenomenon produced in the rarefied layers of the upper atmosphere by Hertzian waves emanating from the sun. The theory of Arrhenius is adversely criticised.—On a new application of optical observations to the study of diffusion, by M. J. Thovert. The optical method described in a previous paper is applied to the determination of the diffusion constants of solutions of the acids, alkalis and some salts. The numbers obtained for the salts accord well with those calculated from electrolytic data by Nernst's diffusion theory; for the acids the observed numbers are smaller than the calculated.—Remarks on a recent note of MM. Nagoaka and Honda relating to the magnetostriction of nickel steels, by M. F. Osmond.—Study of the transformations of steels by the dilatometric method, by MM. Georges Charpy and Louis Grenet. Two transformations can be observed in the iron-carbon alloys by the dilatometric method: the one brusque, produced at 700° C., with contraction of volume, corresponding to the absorption of heat observed at the critical point a_1 in the pyrometric method; the second a more gradual one, taking place at a temperature near that of the critical point a_3 as determined by the pyrometric method.—The action of hydrogen peroxide on oxide of zinc, by M. de Forcrand. The experimental results of the author lead to the conclusion that zinc can exist in three states of peroxidation, Zn_3O_5, Zn_4O_7 and ZnO_2.—On a new phosphate of soda, by M. H. Joulie. Ordinary sodium phosphate is mixed with phosphoric acid until it is neutral to litmus. On concentration, crystals of the new salt separate out; they possess the composition $Na_3H_3(PO_4)_2$. It is pointed out that this salt presents certain advantages from the therapeutic point of view.—Reduction of orthonitroazoic colouring matters: production of substituted derivatives of phenyl-pseudo-azimidobenzene, by MM. A. Rosenstiehl and E. Suais.—On the variation of rotatory power in the esters of stable lævorotatory borneol, by MM. J. Minguin and E. Grégoire de Bollemont.—On the separation of galactose and glucose by the *Saccharomyces Ludwigii*, by M. Pierre Thomas. Glucose is readily fermented by this yeast, but galactose is not attacked. Details are given of the best mode of carrying out this separation, which affords very good yields.—The study of the lactic fermentation by the observation of the electrical resistance, by MM. Lesage and Dongier.—The evolution of branchial formations in the adder, by MM. A. Prenant and G. Saint-Remy.—Study of a liver-wort with thallus inhabited by a fungus, by M. J. Beauverie.—On a fossil Parkeria, by M. B. Renault.—Researches on the modifications of the blood and serum preserved aseptically by heating. The lipolytic function of the blood, by MM. Maurice Doyon and Albert Morel.—Volume in urology. The volume type and the dynamical coefficient, by M. J. Winter.—Experimental researches on the biological life of a xiphopage, by MM. N. Vaschide and Cl. Vurpas.

GÖTTINGEN.

Royal Society of Sciences.—The *Nachrichten* (physico-mathematical section), part iii. for 1901, contains the following memoirs communicated to the Society:—

November 8, 1901:—W. Voigt: The electron-hypothesis and the theory of magnetism. A. Auwers: Right ascensions of 792 stars observed with the meridian instruments of the Göttingen Observatory in the years 1858 and 1859.

December 21, 1901:—V. Rothmund: On the formation of calcium carbide.

The accompanying "business number" contains an interesting account by the presiding secretary of the proceedings in connection with the 150th anniversary of the Society, celebrated in November last.

DIARY OF SOCIETIES.

THURSDAY, MARCH 20.

ROYAL SOCIETY, at 4.30.—Development of the Layers of the Retina in the Chick after the Formation of the Optic Cup: J. Cameron.—On a Peculiarity of the Cerebral Commissures in certain Marsupialia, not hitherto recognised as a Distinctive Feature of the Diprotodontia: Prof. G. Elliot Smith.—The Classification of the Elements: Prof. H. E. Armstrong, V.P.R.S.—Persulphuric Acids: Prof. H. E. Armstrong, V.P.R.S., and Dr. T. Martin Lowry.—On a Throw-Testing Machine for Reversals of Mean Stress: Prof. Osborne Reynolds, F.R.S., and J. H. Smith.—On the Equilibrium of Rotating Liquid Cylinders: J. H. Jeans.—A Portable Telemeter, or Range-finder: Prof. G. Forbes, F.R.S.

LINNEAN SOCIETY, at 8.—Electric Response in Ordinary Plants under Mechanical Stimulus: Prof. J. C. Bose.—On the Fruit of *Melocarina bambusoides*, Trin., an Exalbuminous Grass: Dr. O. Stapf.—On Malacostraca from the Red Sea Collected by Dr. H. O. Forbes: Messrs. Alfred O. Walker and Andrew Scott.

INSTITUTION OF ELECTRICAL ENGINEERS, at 8.—Problems of Electric Railways: J. Swinburne and W. R. Cooper.

FRIDAY, MARCH 21.

ROYAL INSTITUTION, at 9.—Recent Developments in Colouring Matters. (In English): Prof. Otto N. Witt.

INSTITUTION OF MECHANICAL ENGINEERS, at 8.—Fencing of Steam and Gas-Engines: H. D. Marshall.—Fencing or Guarding Machinery used in Textile Factories: S. R. Platt.—Protection of Lift-shafts, and Safety Devices in connection with Lift-Doors and Controlling Gear: H. C. Walker.—Guarding Machine Tools: W. H. Johnson.

EPIDEMIOLOGICAL SOCIETY, at 8.30.—Infantile Mortality in the Tropics: Dr. Daniels.

SATURDAY, MARCH 22.

ROYAL INSTITUTION, at 3.—Some Electrical Developments: Lord Rayleigh, F.R.S.

ESSEX FIELD CLUB (Essex Museum of Natural History, Stratford), at 6.30.—Annual Meeting. The Presidential Address will be delivered by Prof. Meldola, F.R.S., on The Coming of Age of the Essex Field Club, a Record of Local Scientific Work, 1880–1901.

MONDAY, MARCH 24.

INSTITUTE OF ACTUARIES, at 5.30.—The British Offices Life Tables, 1893; an Investigation of the Rates of Mortality in different Classes of the Assurance Experience, and of the resulting Net Premiums and Policy Reserves: T. G. Ackland.

TUESDAY, MARCH 25.

MINERALOGICAL SOCIETY, at 8.—The Petrology of British East Africa: Notes on the Rock-specimens collected by Prof. J. W. Gregory and Sir Harry Johnston respectively: G. T. Prior.

INSTITUTION OF CIVIL ENGINEERS, at 8.—The Greenwich Footway-Tunnel: W. C. Copperthwaite.—Subaqueous Tunnelling through the Thames Gravel, Baker Street and Waterloo Railway: A. H. Haigh.

SOCIETY OF ARTS (Colonial Section), at 4.30.—The Sphere of State Activity in Australia: The Hon. Sir John Alexander Cockburn, K.C.M.G.

WEDNESDAY, MARCH 26.

GEOLOGICAL SOCIETY, at 8.—On a Remarkable Inlier among the Jurassic Rocks of Sutherland, and its bearing on the Origin of the Breccia-Beds: Rev. J. F. Blake.—On a Deep Boring at Lyme Regis: A. J. Jukes-Browne.

CHEMICAL SOCIETY (Royal Institution Lecture Theatre), at 9.—Raoult Memorial Lecture: Prof. van 't Hoff.

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THURSDAY, MARCH 27, 1902.

A GERMAN VIEW OF ENGLISH SCHOOLS.

Der Naturwissenschaftliche Unterricht in England, insbesondere in Physik und Chemie. Von Dr. Karl T. Fischer. Pp. viii + 94. (Leipzig: Teubner and Co., 1901.) Price mk. 3·60.

THIS work treats of the various methods of, and provision for, teaching science, principally physics, in English schools. The author, after a preliminary visit to this country in 1897, was commissioned by the Bavarian Government to spend six months in studying the efforts made in England to introduce the study of science into schools. The variety of organisation which exists in England lends itself to educational experiments, and the preference for boarding-schools, where the efforts of the teachers are not interfered with by parental care, often eliminates a disturbing cause which might influence the results of the experiment. It is remarked, that in comparison with continental schools, the school fees are enormously high; but, without reference to the necessities of the case, the parent is often solaced and his pocket relieved by the bestowal of scholarships upon boys capable of excelling in examination.

The author appears to have sampled the schools fairly well. Besides visiting many universities and university colleges, he saw the Manchester Municipal Technical School; the Technical Institutes at Salford, and at Birmingham and Dublin; the Girls' Central Foundation School; schools at York, Darlington and Leeds; the St. Dunstan's College, Catford Bridge; Tunbridge School; Clifton College, and Harrow; besides some smaller schools. The system of object lessons is described, and details of the syllabuses for elementary physics and chemistry in elementary schools are set forth. Similar details are given of the teaching in preparatory schools and in typical grammar schools, as well as in public schools. The work of the London polytechnics is sketched. The author contrasts the German technical institutes with these, not wholly to the advantage of the English institutions. The statistics of the Science and Art Department are quoted, as are also its programmes.

The author has been wrongly informed that chemical laboratories in Great Britain have only of recent years been open to students. Prof. Thomas Thomson's chemical laboratory at Glasgow and Prof. Hope's laboratory of "natural philosophy" at Edinburgh were available at the beginning of the nineteenth century; and in England, Prof. Turner's laboratory was advertised at least as early as 1834. The laboratory of the Pharmaceutical Society is of about the same age.

After quoting from Helmholtz, Tyndall, the late Prince Consort and Huxley, it is suggested that the effect of classical studies is to influence the imagination, that of science the understanding, and that the latter is to be awakened only through experimental acquaintance with the facts of science; and in England, in contrast with most German schools, the end is gained by laboratory practice. This, of course, can be achieved only by making each student carry out the same operation at the same time; in other words, by laboratory drill, and the system has been carried to a high pitch of perfection. In many schools the so-called "heuristic" method is adopted, according to which children make discoveries under leading strings. A typical syllabus of the methods of inducing children to make such discoveries is given in full. It would be, perhaps, too much to ask that those who inculcate such methods should first have practised what they preach; but when it is remembered that it took the best part of two centuries, and the ablest minds of many nations, to discover the composition of air and of water, it is doubtless hardly to be expected that either young children or their teachers would gain much by this method of teaching and learning. The training of science teachers in England is described, and the methods of South Kensington and its imitators are treated of; the cost of apparatus, too, receives ample notice.

Recent criticism of the "heuristic" system in England is, as proved by ample quotations, not favourable; those who have tried it have had to modify it greatly. Indeed, in the reviewer's opinion (who committed an indiscretion in the same direction in 1882), the conclusions are necessarily drawn from far too restricted premisses. While *very* clever lads are interested, they do not, nevertheless, gain the advantages which might be expected from a consideration of the experiments which they make; and the average student of seventeen or eighteen is simply a machine and his mind a fog—all that he learns is manipulation, and even that is faulty.

The conclusion of the book is an attempt to indicate what the English think of the German system and what the Germans hold concerning English methods. For the last, it might have been well to have waited for a second edition, after the present one had made the Germans better acquainted with recent developments of scholastic attempts in England; for, on the whole, the author has given a very unprejudiced and correct account of his subject.

But many Germans have already made up their minds on the general question. One often hears a German professor say that he prefers a pupil to come to him ignorant of the subject he has to study, but well drilled in classics and mathematics. Indeed, a prominent English teacher of science confessed to Dr. Fischer that he preferred to teach boys trained on the "classical side," who had specialised in science later, to those trained exclusively on the modern side; the words are quoted in English: "They prove better, being of higher standard in character." As the late Prof. Fitzgerald once remarked, in arguing in favour of the retention of Latin in schools: "There is no other subject in which it is possible to set so many small problems all within the reach of a boy's intellect." But the problems of science, unless they are confined to those of mechanics, in the solution of which mathematics may be made to bear its important share, are too subtle for the young mind, as indeed the teacher would find who endeavoured to instruct a class in ethics or in jurisprudence, both subjects well deserving of man's attention. One must ask—to what end is all this energy directed? Is it to educate citizens or discoverers? If the former, then the

reviewer ventures to suggest that better materials exist than such scraps of science which form the pabulum of the average science master, and are reproduced in wearisome iteration in the scores of elementary text-books which it appears to pay our publishers to bring out; if the latter, it must be confessed that our German neighbours, who have not as yet adopted such methods, are more prolific in quantity of research, at least, than we. W. R.

CHEESE-MITES.

British Tyroglyphidae. By Albert D. Michael, F.L.S., F.Z.S., F.R.M.S., &c. Vol. i. (London: Printed for the Ray Society, 1901.)

IF the world sometimes knows little of its greatest men, it often knows still less of its most familiar fellow-creatures. To work out the story of a cheese-mite with proper completeness is a task which many might undertake in a spirit of condescension, only to retire from it helplessly disconcerted. Yet none need be deterred from the enterprise by want of specimens, for though the Tyroglyphidæ are but one family out of many in the host of the Acarina, they produce a population absolutely beyond estimate in numbers. Together with the few species which, in accordance with the family name, are really "sculptors of cheese," there are many others that use a quite different diet. On learning that they like senna as well as dried figs, cantharides as well as French plums, that they are partial to decaying mushrooms, that they eat hay with equine avidity and dote on rush-bottom chairs, the reader will infer that they have a fine catholicity of taste in which our prejudiced palates can only partially follow them. The ubiquity of these minute animals betrayed one experimentalist into believing that he had been able to create them by electricity. From such points of general interest with which Mr. Michael enlivens his introductory chapter, he proceeds to aspects of his subject which have a fascination for many who care nothing for the subject itself. There is seldom a group of animals, however low in popular esteem, that does not occupy a considerable space in the literature of science. Still more rarely, perhaps, has any group escaped all erratic movements in the course of classification. A clear-sighted guide, himself in the forefront of existing knowledge, renders first-rate service to scientific progress in general when for his special branch he shows how the explorers have opened the road for their successors or how they have obstructed it. The path of investigation is ever liable to be deflected, arrested or reverted by the failures of the infallible, the specious finality of those who attempt to do too much, and the slovenly ineffectiveness of those who are content to do too little. Notwithstanding the invariable courtesy with which Mr. Michael writes of his predecessors and fellow-workers, one may perceive from the bibliographical survey here, as well as from that in his earlier work on the British Oribatidæ, that the study of mites has not been wholly free from "regrettable incidents." Immortality at any price seems to be the watchword of those who describe species in such a fashion that no succeeding naturalist can make out what animals precisely were intended by the descriptions. In discussing the common properties of a group and the broad lines of its classification, less harm is done by the careless and the muddle-headed, because their mistakes in these departments can eventually be corrected, and as when thieves fall out honest men come by their own, so sometimes from a conflict of errors truth finds a chance of emerging.

In the ordinary doctrine of text-books the Acarina are distinguished from other arachnids as having, not only the head and thorax coalesced, but the cephalothorax itself completely fused with the abdomen. In the present volume, however, it is pointed out that there is very frequently found a constriction or furrowing of the body behind the second pair of legs. This is held to justify the application of the term abdomen to the part of the organism behind the constriction or furrow. But such an allotment of the first two pairs of legs to the cephalothorax and of the last two pairs to the abdomen would surely be equivalent to severing the Acarina from the arachnids altogether. From segmental demarcation between the second pair of legs and the third nothing more can properly be inferred than that one part of the thorax is more intimately fused with the head and the other part with the abdomen. It is quite true, as Mr. Michael argues, that the Malacostraca are abundantly supplied with abdominal limbs, but these are always sharply distinguished in character from the thoracic appendages, unless in some unique monstrosity. In the case of the Acarina, no perceptible advantage is gained by a theoretical transfer of limbs from the thorax, on which they are normal, to the abdomen, where they would be anomalous.

On other subjects Mr. Michael is much more convincing. His whole discussion of the acarine "nymph" is highly interesting and worthy of admiration. While the larva perhaps never, and certainly hardly ever, has more than six legs, the nymph like the imago or adult has normally eight. The nymphal stage extends from the acquisition of the full number of legs to the last exuviation. There is, however, one group in which it is still uncertain "whether the nubile female is a nymph or an adult." Here the difficulties of investigation are very great, the little creatures being found usually in numbers on the feathers of birds, and, as they will not live away from the host, the isolation necessary for observing the whole series of their transformations seems practically impossible to arrange. Nevertheless, the account given of the genera Hypopus and Homopus shows how difficulties can be made to yield to untiring patience, such as both Mr. and Mrs. Michael evidently combine with other valuable accomplishments. Opinions upon the supposed genera just mentioned have been various and fluctuating. The final result is to establish clearly that the two names in question are not of generic value. They simply refer to a particular stage in the life-history of the Tyroglyphidæ. For designating this stage they are still valid, although they do not add to the musical charm of a sentence by making us speak of hypopial nymphs and homopial hypopi. The difference is concisely expressed by the statement that the hypopus is homopial when "it adheres to its temporary host, not by suckers, but by holding one or more of the hairs of the host between special plates on the ventral surface of the parasite." Suckers facilitate adherence to smooth chitinous insects

and other polished surfaces; claspers are used upon hairy mammals, such as moles and squirrels. A strange part of the business is, that by no means all the young nymphs of a species change into hypopi, and yet that those which do change include both sexes. How little they resemble the form from which they emerge and to which they return is indicated in the opinion entertained by one writer, that the hypopus was a parasite which entered the nymph and ate it up, all but the skin. To accuse it of such ravaging propensities is peculiarly unkind, since it has but a rudimentary mouth and there is little reason to believe that it feeds at all. The innocent purpose of the transformation seems to be merely to secure distribution of the species by varied contrivances for adhesion to moving objects. Acarids themselves are a slow-moving race. Unaided they can travel neither fast nor far, though a Gamasid can traverse four inches in a minute. On the other hand, they multiply with a fertility so portentous that any measures for dispersing the surplus population must be welcome in their commonwealth. But guileless as the hypopi are individually, a heart of stone would be touched at the affliction they cause in mass to the industrious ant. That long-suffering tribe is said to find some twelve or thirteen hundred species of other animals willing to share, or at any rate that are present among, the amenities of its civilised nests. One of these species is the cheese-mite *Tyroglyphus wasmanni*, and Wasmann, after whom it is named, found that a single ant might be infested by fifty, or a hundred, or a thousand, or even thousands of the hypopi, not feeding upon it, but clogging all its organs, so that it could neither talk with its antennæ, nor feed with its mouth, nor walk with its feet, nor clean itself with its combs, till the poor creature, against its will made sordid and useless, would fall into a lethargy and die.

Mr. Michael has long held a foremost place among acarologists. It may be confidently assumed that his reputation, high as it is, will be advanced by the present volume. Though the Tyroglyphidæ are comparatively simple in structure, his skilfully drawn plates help us to understand much in them that is peculiar and to admire occasional features that are really beautiful. Notwithstanding the necessarily technical and systematic character of the work, so many suggestive and critical comments diversify the recital that it will be studied with pleasure by readers who are quite outside the limited circle of specialists. T. R. R. S.

OUR BOOK SHELF.

The Journal of the Royal Agricultural Society of England. Vol. lxii., 1901. Pp. cciv + 403. (London: J. Murray.)

IT is greatly to be regretted that the council of the Royal Agricultural Society has decided to publish the Society's journal in future as an annual volume. For fifty years the journal appeared twice in the year, and during the last eleven years it has appeared quarterly. The alteration now made is a very serious retrograde step. Not only is the space occupied by original articles and reports reduced to nearly one-half of that previously found in the *Quarterly Journal*, but the publication of new matter is now seriously delayed. We have in this country a sad lack of any provision for the publication of important agricultural papers. Besides the weekly agricultural newspapers, we have only the journals of our agricultural societies; these are small annual volumes, with the exception of the late *Journal* of the Royal Agricultural Society. This journal, with a circulation of 10,000 copies, has hitherto done something to provide the required means of publication. In it the majority of the reports by Lawes and Gilbert has appeared. Where could such reports be published now? The question is a very serious one, for it involves the ignorance or instruction of our agricultural readers; and an agricultural society could do nothing more useful than the regular and systematic publication of all work relating to the improvement of agriculture. The *Quarterly Journal* now issued by the Board of Agriculture does not attempt to discharge this function; it is principally confined to the publication of statistical matter and the results of experiments carried out with funds supplied by the Board.

The present volume contains much interesting matter. The long paper on English agriculture in the reign of Queen Victoria is full of facts worth recording, though some strange mistakes are made. What, for instance, was the Royal Chemical Society, founded in 1845 through the efforts of Johnston and Voelcker? The Chemical Society of London, to which the author probably refers, was, in fact, founded in 1841. The Society originated in London. At this time Johnston was a lecturer at Durham, and Voelcker was being educated in Germany, and did not join the Society until 1849! There is a very clear and concise statement by Prof. J. McFadyean on the evidence at present existing as to the relationship between human and bovine tuberculosis. This is a weighty utterance on a most important subject. The paper on English varieties of hops will be welcomed by hop-growers. The articles are followed by the usual reports of the Society's chemist, botanist and zoologist. The most notable result in the Society's experiments at Woburn is the immense effect produced by a dressing of lime in the barley-field; this application of lime has increased the produce by ammonium salts in one case by more than thirty bushels. An appreciative biography of Sir J. H. Gilbert is contributed by Dr. J. A. Voelcker.

R. W.

Selection of Subject in Pictorial Photography. By W. E. Tindall, R.B.A. Pp. 83. (London: Iliffe and Sons, Ltd., 1901.)

MANY of us who frequent photographic galleries or exhibitions have often been struck with the fact that, although a great amount of photographic skill has evidently been bestowed on the production of some particular print, yet in spite of this the effect is not at all pleasing to the eye, and the picture is not "a success." In many cases this is due to faulty composition, the photographer not having paid sufficient, if any, attention to the elementary laws governing this branch of the art. In photography, as in painting, there are many fundamental rules which must be followed to secure a pleasing effect, and the aim of the author of this book is to set out these points for the use of the photographer.

In a series of very instructive and interesting chapters, attention is directed to the composition of all kinds of subjects with which the photographer is likely to meet, and the difficulties peculiar to each class are described.

Further, the author does not restrict himself solely to describing the chief points in the composition of any one subject, but he illustrates them by means of paintings, drawings and photographs, which add greatly to the force of the text.

In conclusion, it may be stated that the author has given us a book which should prove of great service to those who require information on composition in pictorial photography, and a useful addition to the photographer's library.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

The Teaching of Mathematics.

MANY correspondents who hold views much like my own are angry that I should lend my countenance to the sort of reform in mathematical teaching which is now being so strongly advocated by the recognised teachers and by mathematicians. I beg to assure these friends that I am acting in a very consistent way, and I mean to help the reformers so long as they do me the honour to let me assist them.

My dearest wish is that Englishmen should prepare for the new phase in the struggle for existence which has so suddenly come upon the world. I believe that it has been growing for sixty years, that it is going to be very intense during the next twenty years, that it will be important for the next hundred years and that the weaker nations will have been completely defeated before the end of that time, before people in general recognise their foolishness in wasting coal. At Glasgow I was sneered at as thinking that all men were going to be engineers. Would to heaven that I could think of all young Englishmen as being fit to become engineers! I firmly believe that no nation will survive the coming struggle which does not equip itself with that thorough training in applied science which I call engineering. I do not expect to be believed by our schoolmen. They do not know, and they would not care much if they did know. The study of natural science has been discouraged by clerical schoolmasters and ecclesiastics, and men like Huxley worried themselves very vainly in consequence. But the time is quickly coming when, instead of the castigating rod of Huxley, we shall feel the stinging scorpions which fate provides for all men who set themselves to believe lies. There is just one chance for us; it has befriended the English people at several critical times, namely, that however foolish we may be, other nations may be as foolish or even more foolish still; and possibly our people may attend, in good time, to the sort of advice which they so usually laugh at.

I say that if even a small amount of knowledge of natural science and of scientific method could be given to our public men it would be a good thing. Now all influential Englishmen pass their youth and get what is fondly called education at the public schools and the two older universities. I have satisfied myself that the authorities of these institutions will steadfastly set their faces against any such large and radical reform as I have asked for; I was quite sure of this before I gave my address at Glasgow. It was only during the discussion that I began to get hope of any reform whatsoever in these institutions, and now I am sure that, not only is a small immediate reform really possible, but that this reform will increase as the years go on.

It is true that I was thinking of other universities, of other schools and colleges, but if any reform, however small, is possible in these great institutions, surely it is the duty of every lover of his country to help forward this movement. When one thinks that Clifford and Cayley and Sylvester and the other great mathematicians of the British Association Committee of 1873 advocated for English public schools the very reforms in geometrical teaching which are now being asked for, and that in most of the public schools the teaching is even more stupefying now than it was in 1873, one is not likely to be very sanguine. But I have satisfied myself that there is a power now behind the reformers which is very much more earnest and persistent than Clifford could rely upon; indeed, I am satisfied that the reformers have with them the good wishes of every thoughtful teacher of the whole country. And after all, would not even the smallest of reforms be exceedingly important in the public schools of England?

Eton and Harrow and Winchester and the rest, are they not great in every way? Oxford and Cambridge, what greater names are there than these among universities? These institutions in the past have educated the great men of England. I think I see immense faults in them, but when I compare them with all other schools of which I know anything, do I not know that in mental and bodily health their pupils are great in number and in quality? And if just now a time of strain is coming for which these institutions are quite unprepared, shall I sulk and say that because they will not do as I think they ought to do, then it is better that they should do nothing? To tell the truth, I think that our schools with a small reform will be equal to foreign schools even if these have every advantage that the latest notions in pedagogy can give them. Nevertheless, is it not rather the good material that comes to these schools for education than the schoolmasters of the schools that has our admiration? I feel myself that we are arming our people with bows and arrows when we might easily give them magazine rifles with telescopic sights. But surely, if it must be bows and arrows, and nothing better is possible, one is doing good by advocating the employment of the very best kind of bows and arrows.

I asked for a countenance from the mathematicians at Glasgow for a much more radical reform, not in the public schools and the two older universities—there I thought all reform impossible—but in the new universities, in all colleges where the study of natural science, and especially of applied science, is important. Although all the speakers were in favour of reform, quite half of them were out of sympathy with what I consider to be most essential. I know that they represent the great majority of the mathematicians and teachers of the country, and I should like again, however hopelessly, to explain my position to them. They refuse to attempt to look at things from my point of view. Their minds are beautifully in tune; what one scholar says, the mind of another responds to, but if anyone not a scholar of the orthodox type says anything, it is not heard at all, or only that part of the message is heard which is in tune with the receiving brain. My message must continue to seem to them very absurd if they make no effort to synchronise their mental apparatus with mine.

I assert that the orthodox logical sequence in mathematics is not the only possible one. I can imagine a sequence leading men of twenty-five to a proof of the axioms of Euclid; where it would start I do not know, perhaps in Berkeley's notions of sensation and that all matter and motion and shape are merely forms of consciousness. Surely every academic person will admit this as feasible. But he will not admit that there might be a thoroughly logical sequence starting with axioms which are now "proved" after many years of study, the notions underlying the infinitesimal calculus, for example; the notion that a map may be drawn to scale; the notions underlying the many uses of squared paper; the notion that decimals may be dealt with like ordinary numbers.

The swineherd Ho-ti and his son Bo-bo discovered the wonders of roast pork through the burning of their cottage, and they and their neighbours and every mandarin of China who studied the matter considered that it was absolutely necessary to burn a house down if one wanted roast pork. So the cult of house-burning arose in the land. But after many generations there came a sage of the name Pel-li, who pointed out to everybody that it was not necessary to burn houses, as a simple domestic fire was all that was needed. And he and his growing number of disciples were envied till a charge of impiety was brought against him. And of all the hundred accusers of Pel-li, all mandarins of high rank, every one was absolutely honest

and sure that it was really impious to roast pork without burning houses, and so Pel-li and his followers were crucified. If I were to tell my friends that I am Pel-li and that there is a very perfect parallelism between the two cases, they would laugh at the absurdity of such a statement, even if I made it from the cross. And yet, O mandarins, I say to you that you have brought against me the charge of impiety because you cannot imagine any other way of getting to the notions of the infinitesimal calculus than the way in which you yourselves arrived at them, and because I say that they are easier to take in than the axioms of Euclid.

Is it impossible, then, to imagine a different logical sequence from that in which one has been brought up? The very greatest difficulty which I meet with is in getting men to see that if a boy has practised measurement with a scale of inches and tenths of an inch he can understand decimals without a philosophical explanation. This fact, obvious to me, I have not been able to get believed in by any one teacher of arithmetic who plumes himself on his knowledge of the theory of teaching. Well, I go further and say that as an explanation is not necessary for a boy, to give him a grown-up explanation is a crime. Again, I like when dealing with quite easy arithmetic to make boys evaluate most complex formulæ, using all sorts of tabulated functions so that they may regard algebraic signs as a sort of shorthand. I cannot in a few words explain the wonderful mental value of this practice. My critics not only see no value in it, they look upon it with abhorrence. This is not through an effort of their reasoning; it is merely because the thing is strange to them, and, like the Dudley miner, they say, "'Ere's a stranger, Bill, let's 'eave a brick at him." If my critic has any kind of satisfying reason for his abhorrence I suppose it is because he thinks this new custom of mine resembles some most pernicious slipshod habits for which he is continually blaming his pupils—getting off propositions by heart and pretending one knows them; using a rule of arithmetic or dynamics in a mechanical way without understanding why; assuming that one understands a part of an investigation when one does not, and in all sorts of other fraudulent ways pretending to follow a logical sequence and degrading it. Now I also abhor these things. But what my students do is very different and is perfectly logical. They make no pretence of having proved anything, they are merely familiarising themselves with the shorthand of algebra, a thing that they cannot do too soon. If they get to look upon this as the A B C of mathematics they will not after many years of study feel proud of their mathematical knowledge when all they can do is to merely use formulæ in a text-book. Not long ago in an engineering journal the writer of a letter complained that he had been asked to evaluate the expression

$$a\epsilon^{-\alpha t}\sin(bt+g)$$

(being given the values of a, α, b and g) for several values of t. He said he had passed most difficult examinations and knew higher mathematics, but it was quite ridiculous that anyone should expect him to know so much. His anger was extreme. Now some of my students have evaluated things like this before they did any formal algebra at all, but they do not dream of calling it higher mathematics. Surely there is every good in letting a boy become familiar with all sorts of formulæ long before we lead him through the logical sequence which deals with such formulæ, just as we let a boy learn to use words before we teach him grammar or philology. But whether I am right or wrong, I do wish that my critics would try to see exactly what I advocate before they throw blame. The cock-shies that they fling their stones at have nothing in common with any part of my scheme.

I want it to be understood that I advocate a sequence as logical as the orthodox one, or rather, I should say, ever so much more logical, because in the orthodox sequence a boy is really unfamiliar with the ideas to which his so-called logic is applied. The usual sequence may be logical to a philosopher, but it is quite illogical to the average English boy.

I say that what is essential is that the student should be thoroughly familiar through experiment, illustration, measurement and every other possible method with the ideas to which he applies his logic. Also that the study should be of interest to him. I submit that the sequence which I recommend can really be made interesting to the average English boy, whereas the orthodox sequence is painfully uninteresting to him. One reason for this great interest lies in its immediate application to all sorts of actual problems such as he meets with in the study of natural science, and I do not care to hide the fact that there is a special interest which is due to the usefulness of the results of the study in the life-work that lie before him. If anybody cares he may misrepresent me here to any extent. Over and over again the academic person has been kind enough to sneer at my utilitarianism as if I were sacrificing the spiritual for the material, as if engineering were a thing of mere formula. On this I can add nothing to what I have already given in my British Association address and in my other papers. But if my critics only knew what wonderful regions of logical thought and high emotion are connected with the practical applications of natural science, if they had the respect which I confess to have for common things, they also might say as Heracleitus said of his kitchen with its pots and pans, "Here also are the gods." In his typical poem "Shop," Browning takes the college-common-room point of view. Heavens, what a sordid narrow point of view it is! The Bloomsbury bric-à-brac shopkeeper gets all the poet's scorn because he does not hate shopkeeping, because to him "shop was shop only." Does anybody imagine that Shakespeare could not have glorified the life of the shopman? But this poet, with all the arrogance of his caste, says, "I want to know a butcher paints, a baker rhymes for his pursuit." The moment a man has leisure he must escape from his trade! For my part, I believe that whatever a man finds to do he ought to do with all his might and with all love and devotion, or not attempt to do it at all. If he hates shopkeeping, let him give it up to someone else to whom shopkeeping is a perfect happiness. If Ruskin's influence over a man has been great enough to prevent his seeing the romance, the wonder of engineering, so that it is to him a mere trade by which he earns his bread and butter, in heaven's name let him give it up altogether and take to art criticism. For my lovely mistress, Applied Science, scorns a divided worship. It is disgusting to see young engineers who cannot compute, who know nothing of science, whose souls are not engrossed all the time with the greatness of their profession, who never think of their business after office hours, who think it all a mere matter of formulæ and tools. If they were fit for their work their lives would fill with happiness, and even the power to rhyme and paint and to create music might belong to them; but woe unto the nation whose shopkeepers scorn shopkeeping while they paint or fiddle; whose schoolmasters rely on cricket and a housemaster to do their proper business whilst they discuss Browning and the musical glasses. To make a man fit for, so that he may also love, his profession, is this a function to be scorned by schools and colleges? and am I to be sneered at as a utilitarian because I consider this a most important function of the schoolmaster?

Nobody has contradicted my statement that the orthodox method of cramming average boys with demonstrative geometry stupefies them and makes them hate mathematics all their life after. May I also point out that the beautiful philosophy of Euclid is also degraded, just as the literature of Greece and Rome is degraded, by our school methods. Is there anybody

who does not think of Euclid merely as a lower school subject? At the British Association discussion a great mathematician was astonished that I should ever have had to study the fifth book of Euclid. He said he was more fortunate, because he was never taught it. Well, I was never compelled to study it, but I took to it through mere affection such as my critic deems it his good fortune never to have experienced. What I regret is that any kind of demonstrative geometry was given me when a boy, but since it was given me I am glad to think that I had Euclid's philosophy undefiled. I even dipped into those books now never published—the seventh, eighth, ninth, tenth, and also the thirteenth, fourteenth, and the books added by some Greek author whose name I forget, the fifteenth and sixteenth. At the same time, I feel that if demonstrative geometry is to remain a school subject for the average boy, it is absolutely necessary to replace the second and fifth books by algebra. The view to which I hold most firmly of all my views about the teaching of mathematics is that demonstrative geometry ought never to be taught to boys at all; it ought never to be taught in schools. It is a higher university subject. Euclid's treatment of proportion and of incommensurables is one of the most beautiful parts of that exact philosophy which the conventional schoolmasters are constantly seeking to degrade. The old philosophers thought that only a very few men of the most acute race that ever lived on this earth were fit to begin the study of geometry, and we use it as "an instrument for the cultivation of the mind" of the average young barbarian. Even my sense of the parlous state of the country cannot prevent me from grinning at the Rabelaisian humour of the position. Boys are not swine, but if you will force pearls upon them for food (poor boys, they do not know that the pearls are only cheap imitations) you must expect but small results either physically or spiritually. It must always be a pleasant memory to them, however, that they once did have pearls to trample under foot or to give them indigestion, and one may say that they are fairly safe from pearl hunger all the rest of their lives. Will any of my opponents deny that they ceased to study Euclid when they left school, except in the way of their trade as teachers? How many of them know anything of—I need not say Euclid's real philosophy—but even of modern geometry and the beautiful system of transversals developed by the Irish geometers? I recollect a lovely year of my life in which I was introduced to three new things—Tennyson's "Idyls" and McDowell's "Geometry" and Homer's "Odyssey" (Bohn's translation), and I hardly know even now which of the three gave me most pleasure. But I had had the good fortune not to have pearls forced upon me as a boy. Yes, Cæsar wrote a book for the third form; what man who ever passed through the third form would now read Cæsar? Euclid wrote a book for the lower school; a lower school book let it remain.

And $(a+b)^2=a^2+2ab+b^2$ is equivalent to II. 4. And if $\frac{a}{b}=\frac{c}{d}$, then $\frac{ma\pm nb}{pa\pm qb}=\frac{mc\pm nd}{pc\pm qd}$, and this is equivalent to the immortal philosophy of the fifth book. "Great God, I'd rather be a pagan cradled in a creed outworn!" I would rather be utterly ignorant of all the wonderful literature and science of the last twenty-four centuries, even of the wonderful achievements of the last fifty years, than not to have the sense that our whole system of so-called education is as degrading to literature and philosophy as it is to English boys and men.

We are not the heirs of all the ages, and we shall not for very long remain in the foremost files of our time if we depend upon the schoolmasters. I place my faith in the common sense of the common people. In one way or another I find that they are learning to compute, to gain a knowledge of natural science. I know of many hundreds of night-school boys who were poor who are now successful engineers, and already youths are being warned from trying to become engineers because their public school education would actually prevent their having a chance of success. They cannot understand the most elementary lectures in applied science. I know of a large employer who has already told the headmaster of a great public school that he will no longer employ public school boys unless a more rational method of teaching mathematics is adopted. And he is a public school boy himself! I am constantly being asked to recommend men to teach mathematics in technical schools and colleges, and warned that I must not recommend a Cambridge man. There is nobody who has a higher respect for Cambridge mathematics, for the achievements of past and present Cambridge men, than I have; but if Cambridge men will put themselves altogether out of sympathy with the needs of young engineers; if they will make no attempt whatsoever to look at things from the new point of view to which we have been forced; if without any attempt at examination they will in an off-hand way settle it that what we ask for is an illogical and soul-debasing non-educational preparation of an olla podrida of mere formulæ, then in sorrow and not without some anger we must try to get on without them. They do not know what a lovely bit of fighting they are leaving us to do all by ourselves, but I sincerely hope that they will not hamper us. Indeed, they must sooner or later help us against the common enemy, even if they are only to be armed as were the children of the mist. Because Isaac Newton was such a superb bowman and the English yew was ever the finest of materials, they will insist on the use of the antiquated weapon only. I sincerely hope that the English yew, which is very much of a graveyard tree, may not yet flourish over the grave of British industry.

But enough of these notions. I see a great fight ahead of our people, and bows and arrows are better than no weapons, as a twentieth of a loaf is better than no bread at all, and I welcome any instalment of reform, however small, in the teaching of mathematics in the public schools of England. And so long as my help is not rejected on the ground that I openly ask for a much greater reform and may be dangerous to my friends on that account, so long am I anxious to give my help and proud that it should be accepted.

JOHN PERRY.

Birds attacking Butterflies and Moths.

WITH reference to my previous letter in NATURE (January 16), I would say that the butterfly referred to was the *Terias silhetana* or *Terias laeta*, probably both.

Another bird that frequently catches these butterflies on the wing is the Indian Bee Eater (*Merops viridis*).

During a Christmas camp this season I came across a field where some twenty or thirty King Crows were busily engaged in catching butterflies; the day I first saw them, butterflies were numerous in this field, and it was easy to get undamaged specimens of *Terias silhetana*, *Terias laeta*, *Junonia lemonias*, *Tarucus theophrastus*, *Lampides elpis*, *Catopsilia pyranthe*, and some others which were not being caught in flight. Some three or four days later few King Crows were to be seen, the butterflies were much diminished in number, and nearly all those caught were damaged specimens. The birds perched on the tall dry Jowari stalks and made short flights on all sides, catching their prey sometimes on the wing, sometimes on the ground.

I could not say with certainty what butterflies were caught on the wing.

The King Crow and the Bee Eater are two of the commonest birds in this part of the country, and must cause a good deal of destruction in the course of a year.

ANNIE E. MCKAY.

India, February 21.

"Nature-Study" Exhibition.

WILL you kindly permit me, while thanking you for the attention which you have already directed towards the above exhibition, to state that it has now been arranged to hold it at

the gardens of the Royal Botanic Society, Regent's Park, on July 23 and following days? It will be open to colleges and schools of every grade, and the exhibits will include all that bears upon Nature-study. Happily the project has secured very influential support, and has aroused considerable interest.

Sir John Cockburn, K.C.M.G., is chairman of the executive committee, and Mr. Charles Savile Roundell, of 7 Sussex Square, Brighton, is hon. treasurer.

I shall be happy to furnish full particulars, or to meet anyone, who may wish to see me personally, at any time by appointment either at the Botanic Gardens or in St. James's Street, S.W.

JOHN C. MEDD
(Hon. Sec. *pro tem.*).

Stratton, near Cirencester, March 19.

Sounds associated with Low Temperatures.

THE accompanying extract from a letter recently received from Norwich raises a question that I cannot answer. I have never experienced the fact named. Have any of your correspondents ever done so?

W. H. PREECE.

"On February 18 the temperature went down to zero here. As my son walked about the sheds, he was struck by the whistling noise the ground made, which he says he has noticed each time such an extremely low temperature has occurred, and he reminded me how we had once noticed it together a great many years ago. Now what makes that whistling, and does it always accompany a zero frost?"

Proofs of Euclid I. 5.

I REGRET that in my letter of March 13 (p. 439, line 4) the letters A, B were inadvertently used by me instead of B, C.

I have tried Mr. Croome-Smith's proof (NATURE, March 20, p. 466) on a class of beginners, but it is difficult to convince them that, in the words of the professional conjurer, "there is no deception."

A non-mathematical friend has just written, pointing out that so long as we define a square as a four-sided figure having all its sides equal and all its angles right angles, it is somewhat inconsistent to trouble the beginner with proving properties of an isosceles triangle the truth of which he can readily see for himself at a glance. Either we should make him prove the properties of a square or we might just as well define an isosceles triangle as a triangle having two sides equal, and the angles opposite these sides equal.

G. H. BRYAN.

THE NATIONAL PHYSICAL LABORATORY.

THE Prince of Wales, who was accompanied by the Princess, formally opened the National Physical Laboratory on March 19, in the presence of a distinguished company of men of science and others interested in national progress. In declaring the laboratory open, His Royal Highness said:—

I am glad that my first duty as a Fellow of the Royal Society should be to join with my distinguished brethren in opening this institution, the direction and administration of which have been entrusted to the Society by the Government. It is also a great pleasure to assist in the inauguration of what may fairly be called a new departure, for I believe that in the National Physical Laboratory we have almost the first instance of the State taking part in scientific research. The object of the scheme is, I understand, to bring scientific knowledge to bear practically upon our everyday industrial and commercial life, to break down the barrier between theory and practice, to effect a union between science and commerce. This afternoon's ceremony is not merely a meeting of the representatives of an ancient and world-renowned scientific society for the purpose of taking over a new theatre of investigation and research. Is it not more than this? Does it not show in a very practical way that the nation is beginning to recognise that if her commercial supremacy is to be maintained greater facilities must be given for furthering the application of science to commerce and manufacture? In the profession to which I am proud to belong there are, perhaps, special opportunities of gaining a certain insight into the general trade and commerce of the world and of comparing the commercial vitality of the different countries. And certainly abroad one finds an existing impression, which was confirmed by the experience of my recent and interesting colonial tour, that the superior technical and scientific knowledge of our foreign competitors is one reason why our hitherto preeminent position in manufactures and commerce is so considerably threatened. As a simple example I may quote the opinion of an expert authority in Australia, that the aniline dyes of Germany had given to a certain class of German-made goods a decided superiority over those of British manufacture. In Germany and America much valuable work has been carried out by the State. In this country the Government have provided these buildings and found machinery for the supply of light, heat and power. They are at present not inclined to spend more money upon equipping the laboratories. It is therefore to the liberality of the public that we must look, not only for money, but for presents in machinery and necessary appliances. Already the institution has benefited in the latter respect by gifts from Sir Andrew Noble, the Drapers' Company, Messrs. Willans and Robinson, Lady Galton, and others. The old-established Kew Observatory now forms part of the laboratory. Important and growing work is carried out in the testing of telescopes, binoculars, sextants and, more particularly, telescopic sights for the Navy. Most of the scientific outfit supplied for the Antarctic expedition was tested at Kew. The laboratory will also supply a want which is much felt for standardising and testing the many other forms of apparatus in daily use, while investigations will be carried out on points of importance to the manufacturer or the merchant from the solution of which valuable results may be expected to accrue. I am particularly pleased to know that it is possible that within the precincts of this laboratory there will be established a work of the utmost importance—namely, a tank after the design of the late Mr. Froude, in which the performance of a ship can be predicted from experiments on a model. At present there is such a tank at Haslar, which is fully occupied in Government work. The Institution of Naval Architects, impressed with the demand for this work, have proposed to raise the sum required to erect the tank and for the necessary appliances. But the funds at present at the disposal of the laboratory will require to be considerably supplemented if they are to undertake this much-needed work. No doubt the working expenses of the tank will ultimately be met by fees. But a difficulty may arise in tiding over the interval which must elapse before such fees are available. I am confident that, through the generosity of the public, the necessary means will be forthcoming to meet these difficulties and to secure that which is almost an essential to the shipbuilding industry of a country possessing the largest mercantile marine in the world. Before such an audience I have not presumed to speak of the value to science of this institution. Though the Navy has given many notable names to scientific theory, it is the practical results which naturally appeal more to the mind of the sailor, and I am sure you will accept this as my excuse for having ventured to make my few remarks upon the future of this institution from merely a utilitarian point of view.

At the close of the ceremony, in responding to the vote of thanks, the Prince of Wales announced that Sir William Armstrong, Whitworth and Co. had promised to subscribe 1000*l*. towards the funds of the laboratory; and he expressed the hope, which all of us share, that this excellent example will be promptly followed by other manufacturing firms. We give below some particulars of the work already instituted at the laboratory.

The opening ceremony took place in the engineering laboratory, in which about 900 guests were accommodated. This had been cleared for the occasion, and the only machines left in position were a shaping machine by Baker and Co., of Halifax, and a ten-ton testing machine. The latter is one of Messrs. Buckton's vertical machines. The stress is applied direct by means of a hydraulic ram worked off the main, in which there is about 100 feet of water pressure, so that no intensifier is necessary; the supply from a small cistern fixed to the wall is sufficient to bring the ram back when the pressure is relieved. The machine is intended primarily for experimental work in connection with the alloys research; for this it has conveniences which a more powerful instrument

would not possess, while at the same time it may be useful in making accurate tests on small specimens; such tests the committee is prepared to undertake, though it fully recognises the desirability of erecting a large machine as soon as funds will permit. The usual accessories for torsion and bending tests are fitted; there is also a simple autographic gear.

The pressure pumps for the gauge-testing work supplied by Messrs. Schaffer and Budenberg were placed temporarily in an adjoining room. These are two in number; one is arranged to test simultaneously ten or twelve gauges up to a pressure of 600 lbs. to the square inch; the pressure is applied by a force pump and a screw plunger. In the other, a pressure of twelve tons to the square inch can be obtained easily. The indicator-testing apparatus given by Messrs. Willans and Robinson has not yet arrived. In the engine-room the 75 kilowatt Parsons' turbine was running, and proved an attraction to many visitors. The normal voltage of this machine is about 105. The room also contains a 10 kilowatt dynamo by Thomas Parker and Co., driven by a Crossley gas-engine and a motor generator set also by Parkers. By means of regulating resistances, the dynamo of this set can be made to run at voltages between 10 and 60. There are three storage batteries, each of about 55 chloride cells, in the Laboratory, and by running the generator in series with the main dynamo each of these can be charged. But in experimental work the cells are likely to be unequally used; the generator alone can then be used to charge groups of cells which require special treatment.

With regard to the physical part of the Laboratory, it must be remembered that the staff has only been in the building for a very short period, the electrical rooms were not ready for occupation until about ten days before the opening, and, further, that the funds at the disposal of the committee have sufficed to purchase only a limited equipment. The aim of the director has been to complete as far as possible the apparatus required for experiments which it is hoped to undertake at once; no apparatus has been bought without an express and immediate object in view. The thermometric department is perhaps the most completely fitted. The main laboratory has been divided into two by a partition of soft brick and glass. On the one side are the various furnaces and heating appliances, on the other the measuring instruments which it is desired to keep at a uniform temperature or to protect from fumes. The brick can easily be drilled to allow the passage of wires, tubes, &c.; through the glass the observer can see what is happening on the other side of the partition. Appliances were shown for standardising thermometric instruments from the temperature of liquid air up to 1000° C. or 1200° C. This laboratory is in the charge of Dr. Harker, who has shown much ability in arranging the various appliances.

For the liquid air there is a Hampson liquefier attached to a Brotherhood compressor, which is driven by a 5 h.p. motor by Laurence Scott and Co., of Norwich. For boiling-point observations and for calibration, the standard apparatus as used at Sèvres has been fitted. For temperatures between boiling point and 200° C. to 250° C. an oil bath has been constructed. This consists of a wide U-tube of copper having a junction across the upper part of the U. In the one limb is a stirrer driven by a small motor, in the other the thermometers are placed; thus a continuous stream of oil is driven rapidly past the thermometers. The whole is jacketed and heated by gas, and careful observations have shown that the temperature over the whole of the vertical column is remarkably uniform.

For temperatures up to about 600° C. there is a similar bath of iron containing a mixture in equal parts of the nitrates of potassium and sodium.

The higher temperatures up to nearly 1200° C. are obtained in an electric oven similar to that used by Messrs. Holborn and Day at the Reichsanstalt, and the director is indebted to President Kohlrausch for kind assistance in procuring the materials for this. The oven, which was the gift of Sir Andrew Noble, consists of a series of tubes of porcelain and fireclay carefully lagged with asbestos; round the innermost tube a nickel wire is coiled; this is heated by a current, and a remarkably steady and uniform condition of temperature is obtained; the regulation of the temperature is easy, and there are no fumes to contend with.

For success with the oven it is necessary that the electric supply should be uniform; a special battery of 56 cells has therefore been installed. This has been arranged in four groups of 14 cells each, and by means of a specially devised switchboard these can be combined in various ways to give the required current and voltage. This battery was the gift of Sir Andrew Noble, to whom also is due the gas thermometer which at present forms the standard of reference. For secondary standards, mercury thermometers will be used up to 250° or possibly rather higher; above this platinum thermometers, or possibly thermopiles, will be adopted. Among the exhibits were three thermal-junctions most carefully standardised by Prof. Holborn, which will form a link between the Laboratory and the Reichsanstalt; there was also a platinum thermometer in a quartz tube, very kindly given by Mr. W. A. Shenstone. A cathetometer set up temporarily against the wall attracted special notice.

At no great distance from the thermometric laboratory is the mercury pressure gauge. A glass column some fifty feet high has been fixed to the wall of the laboratory; alongside this is a steel scale, divided into millimetres, pounds per square inch, kilogrammes per square centimetre, and feet of water; thus gauges up to a pressure of 250 lbs. to the inch can be tested directly against the column. A lift erected close to the column enables the observer to read the height of the mercury. The pressure is applied by means of compressed air contained in a bottle connected both to the gauge and the mercury column. The bottle will be filled from the Brotherhood compressor which works the air liquefier. For standardising gauges between 250 and 400 lbs. pressure, a loaded piston apparatus—a gift from Messrs. Willans and Robinson—will be available; for pressures above this, apparatus has to be constructed.

The metallurgical department is housed in the old kitchen, in which there was an interesting exhibition of photographs of metallic sections and cooling curves, lent by Sir William Roberts-Austen. The apparatus for investigating cooling curves has yet to be bought, but a beautiful photomicrographical outfit by Zeiss was shown by Dr. Carpenter, who exhibited to a number of the guests the section of a steel rail magnified four hundred times; the pearlite and ferrite structures were clearly visible; the rail had been rolled cold and the grains were elongated by the rolling. The projection apparatus is very complete; the arrangements for cutting, grinding and polishing the sections are also ready; the polishing apparatus has been specially designed by Mr. J. E. Stead, and the laboratory is prepared to undertake the microscopic examination of sections for the railway companies or other users.

A room adjoining the microscope is arranged for metrology, and here were set up a dividing engine by the Société Génevoise pour la Construction d'Instruments de Physique. This instrument was given by Sir Andrew Noble, and is a copy of that in use at the Bureau International, but without the automatic mechanism—this, however, can be added if funds permit. It will divide lengths of 1 metre or less. The room also contained a Whitworth measuring machine, a set of standard gauges, surface plates, &c. A set of screw gauges had most kindly been lent by

Messrs. Sir W. G. Armstrong, Whitworth and Co., who exhibited in addition Sir J. Whitworth's original measuring machine. A Pratt and Whitney measuring machine has not yet arrived. In an adjoining room, thanks to the courtesy of Sir F. J. S. Hopwood and Mr. Chaney, there was an interesting exhibit from the Standards Department of the Board of Trade. King Henry VII.'s yard and Queen Elizabeth's pints were shown in proximity to our modern standards.

The electrical rooms are three in number. One of these, in the basement, has a constant-temperature chamber attached, and here were the British Association standards of resistance; the coil "Flat" made by Matthiessen about 1864 and used by the original British Association Committee on Electrical Standards was shown to visitors, as well as some modern standards.

The main electrical laboratories, however, are far from complete; one of these, which is to be used for the fundamental units and standards, was occupied as a tea-room. In the other, Mr. Campbell had, in the ten days which had been available, set up some secondary standards in their permanent positions, while other apparatus was exhibited on tables in the middle of the room. A few antiquated scales of historical interest aroused some criticism. They were merely placed on the tables with the other apparatus to indicate that a galvanometer with some proper arrangement of lamp and scale formed part of the installation required.

The fundamental standard of electromotive force will be the Clark cell, while current will be measured by the drop in volts over a known resistance; but for secondary standards a Kelvin multicellular voltmeter of somewhat special construction, a set of Kelvin balances and some Weston instruments will be employed. The voltmeter is read on a long scale in the form of the arc of a circle some two metres in radius. Between 60 and 110 or 120 volts the scale is a very open one, some 5 cm. corresponding to one volt. Thus it is easy to read to the tenth of a volt. For use with the instrument a special resistance box containing ten coils has been wound by Mr. Campbell.

The first coil of 10,000 ohms resistance is divided into two parts. One of these has a resistance of 1500, the other of 8500 ohms; each of the others is 10,000 ohms. Each coil is of manganin, wound in sections, which are arranged so as to be non-inductive, and each coil will stand an E.M.F. of more than 100 volts. Thus 1000 volts may safely be applied to the whole. A current can be passed through the whole box and adjusted by means of external resistances until the drop between the first and second terminal just balances the E.M.F. of one Clark cell—14,340 volts—in series. In this case the drop across each coil after the first is 10 volts, and by connecting the voltmeter in turn to the proper terminals of the box its scale can be calibrated. When this has been done the instrument is ready for reading directly potential differences between 50 and 120 volts; below 50 the scale is too contracted. To measure voltages above 120 volts, the box is used; the total volts are put on between the end terminals; the box enables these to be subdivided to tenths, and a convenient number of tenths can be measured directly on the voltmeter scale.

In another corner of the room were the standard air condensers of the British Association; these, which consist of a series of concentric cylinders, have been described by Mr. Glazebrook in some of the reports of the Electrical Standards Committee; on a table near by was shown the apparatus for determining their capacity, a Wheatstone's bridge box of platinum silver coils by Elliott Bros. and a rotating commutator made by Pye and Son, of Cambridge, the speed of which is controlled by a stroboscopic arrangement viewed through diaphragms attached to a standard fork.

It is intended at once to set about constructing from these condensers standards of capacity for commercial use.

On another table was set up in a convenient form the apparatus for measuring by the ballistic method the permeability and hysteresis of an iron ring, while close by the latest pattern of Ewing's permeameter was on exhibition.

In the centre of the room were shown two resistance boxes by Wolff, of Berlin; one of these was a potentiometer box with a wide range of applicability, the other an ingenious modification of the Kelvin double bridge which is used extensively at the Reichsanstalt for the measurement of small resistances.

The commercial testing of iron and steel or of measuring apparatus, if undertaken on a large scale, will probably be carried out ultimately in a room attached to the engineering laboratory; most of the arrangements which have just been described are fitted rather for the construction and verification of secondary standards than for purely commercial testing.

A fourth wing of the building contains the chemical laboratory, which calls perhaps for no particular description; it was described as workmanlike by a very capable judge on the nineteenth, and that may suffice. A chemical laboratory is essential, but it is not desirable that it should be very elaborate.

The laboratory contained a large collection of glass vessels, flasks, burettes, &c., lent by Messrs. Gallenkamp; these were intended to illustrate one branch of the new work, the standardisation of such apparatus for which there seems a great opening. The vessels exhibited bore the stamp of the Reichsanstalt.

The system of electric wiring adopted requires a special notice. There are two distinct sets of circuits; one of these, connected to the lamps and to numerous plug points, is fed from the dynamo or the cells at a steady voltage of 100 volts. It is used for lighting and for the supply of power.

For the experimental work there is a separate battery of 55 cells. These are arranged in groups of 5, the first group being further subdivided; the positive poles of the cells are connected to a series of horizontal brass bars at the back of the main switchboard; the negative poles are connected to a series of isolated blocks, which, by means of switches on the front of the board, can be put into contact with the corresponding horizontal bars; the positive pole of each group is one bar lower than the negative pole of the same group. Thus if the switches are all closed the cells are in series; the top horizontal bar is negative, and there is a constant rise of 10 volts between each two consecutive bars. On the front of the board are a series of vertical bars, and from the tops of these the experimental circuits, of which there are thirty, lead away through fuses. These vertical bars can be plugged through to the horizontal bars at the back, and thus a series of voltages rising by steps of 10 volts can be distributed through the building.

The normal discharge rate of the cells is 50 amperes, but to obtain higher rates the cells can be connected in groups of five in parallel. To do this with all the groups, all the switches are opened; two specially heavy vertical bars are then connected by plugs, the one to all the positive poles, the other to all the negative poles of the battery. From these bars two circuits capable of taking 500 amperes lead away.

The switchboard, which is a modification of that at the Owens College Laboratory, was designed by Mr. G. A. Steinthal, of Bradford, in accordance with the suggestions of the director. Mr. Steinthal has carried out all the experimental wiring. The distributing wires are for the most part bare copper, and are carried on porcelain insulators. Some of these wires go directly to the various rooms, and are so arranged that it is possible in any room to obtain simultaneously at least two different voltages. Others of the distributing wires go to three subboards arranged in a similar manner to the main board; four circuits from the main

board go to each subboard, and twelve subsidiary circuits leave it. In the main electrical laboratories there are five of these subcircuits, and to avoid magnetic action concentric wiring has been used in the section. Each board is fitted with a voltmeter, so that the voltage can be tested before connection is made with any instruments. Thus the electrical equipment, so far as it goes, is unusually complete. It should be noted, however, that provision is still required for alternating current supply and for voltages above 110 volts. Arrangements have been made by which the experimental battery can be put on to the lighting circuit, or run in series with the lighting battery to get 220 volts, but it is not anticipated that this will often be done. As soon as funds permit, the outfit will need supplementing in this respect.

It will appear from the above that there is much to be done before the Laboratory can be called complete; still, for many branches of its work it has the means to start, and its success in these will lead to increased opportunities for development.

THE SCENERY OF ENGLAND.[1]

IT is curious to reflect on the history of man's inquiry into the origin of the landscapes among which he has lived for so many thousand years, and to find how recent is his intelligent interest in the subject. Within the memory of many who are still alive and active, the present topography of the land hardly came within the scope of scientific investigation, and while the utmost energy and enthusiasm were displayed in unravelling the secrets of the rocks below the surface and thus reconstructing the geography and scenery of the successive eras of the geological past, only meagre attention was given to the causes which had brought about the existing features of that surface. The popular notion that everything remained as it had been from the beginning was known to be untenable and absurd; nevertheless, the subject failed to excite the interest of geologists as a body. Some of them were Wernerian tories, others Plutonist conservatives or Uniformitarian liberals; but whatever might be their geological creed, they were for the most part Gallios in this matter, never caring to set themselves seriously to consider how their familiar hills and valleys were in detail to be accounted for.

Yet the way had been shown to them generations before. It had been opened up by Lazzaro Moro and Generelli in Italy; by Ray and afterwards by Hutton and Playfair in this country; and by Guettard and Desmarest in France. Living on an island and accustomed to continual tales of the destruction wrought by the sea on the margin of the land, British geologists, largely influenced in later years by Lyell, had come to look upon the sea as the prime agent in the degradation of the terrestrial surface. They had no theoretical objection to depressing or uplifting the land to any extent that might be desired, in order to account by marine erosion for any particular topographical feature. While admitting the existence of what were called "valleys of denudation," they thought it much more probable that these hollows had been scooped out by violent inundations of the sea, or by ocean currents moving with great velocity over the submerged country, than that they could have been carved out by such seemingly feeble agents as the rivers that flow in them. The admirable demonstration given by Desmarest, as far

FIG. 1.—Granite Coast, Cornwall.

[1] "The Scenery of England and the Causes to which it is Due." By the Right Hon. Lord Avebury. Pp. xxvi + 534. (London: Macmillan and Co., Ltd.) Price 15s. net.

back as 1774, that a system of valleys, like that of Auvergne, had been carved out by running water in a series of rocks of varying powers of resistance, including even thick and wide sheets of solid lava, failed to impress the geological mind. The subsequent enforcement of the same lesson from the same region by Poulett Scrope in 1826, and three years afterwards by Lyell and Murchison, likewise roused no general interest. English geologists, while they admitted that such a process of land-sculpture might very well be allowed to have been effective in the heart of a foreign country, far from the sea and high above its level, remained true to their impression that, by invoking convulsions of the solid ground below and sufficiently destructive operations of the sea above, they could satisfactorily explain all that seemed to need explanation in the topography of the land. How deeply rooted this prejudice was is well shown in the memorable paper by Ramsay on the denudation of South Wales and the adjacent English counties, published in 1846. This great classic holds, and deserves to hold, an honoured place in geological literature, as the first concrete attempt to work out in some detail the denudation of a region with reference to its geological structure. Yet at that time, being as marine as the staunchest adherent of the old faith could desire, its author scouted the idea that rivers and streamlets had played any notable part in carving out the valleys of the country. With the naïve remark that "it is not to be expected that an unaccustomed eye should at first detect all the evidences of the former action of the sea on these lands," he affirmed that "we must either adopt the theory that the great features of the land have resulted from the ordinary action of the sea, or else revert to the hypothesis of great bodies of water violently rushing over the surface." These views continued to prevail for twenty years longer. Their last champion was probably the late Dr. D. Mackintosh, whose "Scenery of England and Wales" appeared in 1869.

But some years before that date the first step in the application of Hutton's teaching to the history of the valleys of this country had been taken by Beete Jukes, who broke new ground and opened the eyes of his brother geologists to the true nature of the problems of topography by the publication of his ever-memorable essay, "On the Mode of Formation of River Valleys in the South of Ireland," which was issued in 1862. The examples cited this time were not from a foreign country, but from our own islands, where they could be judged of and criticised in the light of all that was known of a similar nature in other parts of Britain. The process of time had fitted the soil of the geological mind for the seed, and it soon sprang up and bore fruit. Next year (1863) Ramsay showed in the first edition of his "Physical Geography and Geology of Great Britain" that his old faith was weakened, and that he was prepared to follow his friend and colleague in what was really a return to the Huttonian fold. At that time the Geological Survey was at work on the Weald under Ramsay's supervision, and had to face the problem of its denudation, which had been so often described and discussed and had so complacently been assumed to be a proof of the levelling action of the sea. For the first time in England a tract of country which was geologically mapped in detail was simultaneously subjected to a searching inquiry as to the history of its topographical features. The officers of the staff, after an exhaustive examination of the ground, were led to discard the doctrine of marine erosion and to adopt in its stead that of long-continued subaërial waste. They showed convincingly how this explanation reconciled all parts of the evidence, and how each new

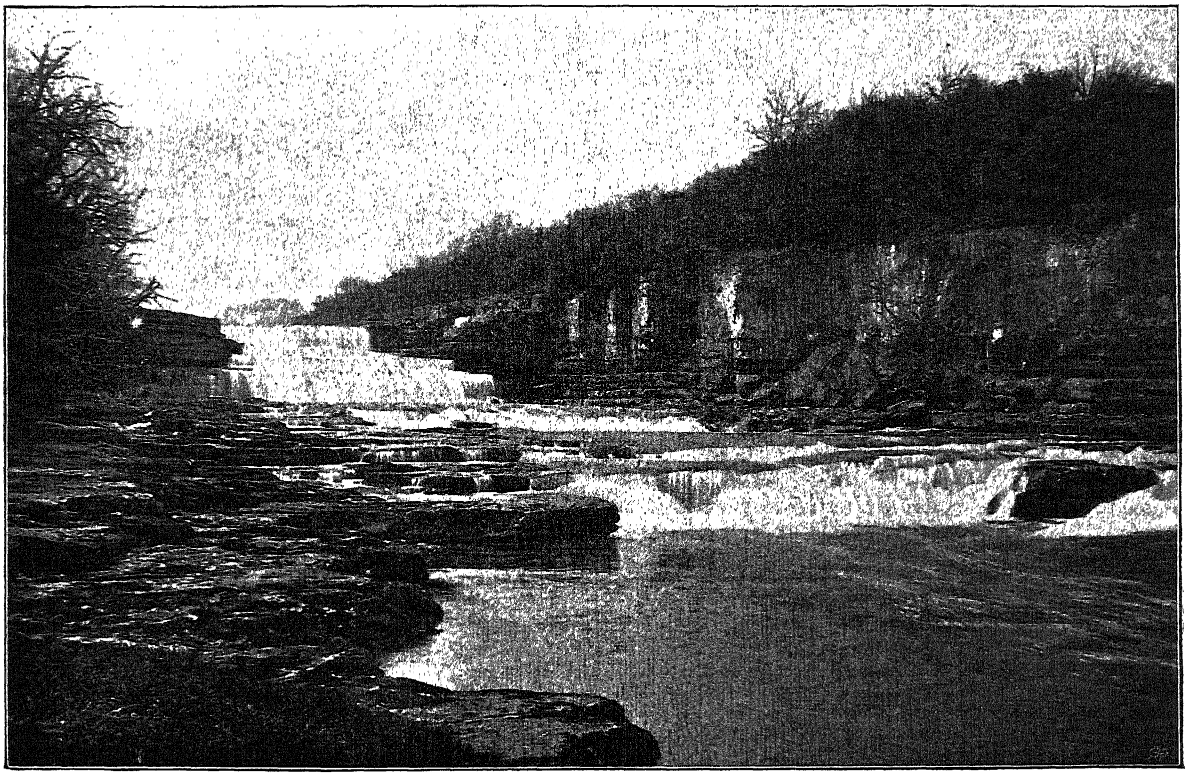


Fig. 2.—Lower Fall, Aysgarth, Wensleydale, Yorkshire.

observation advanced and confirmed the deduction that the valleys which diverge from the Weald began to be eroded by the streams that flow in them when the drainage descended from the still existing dome of chalk, and that during the enormous time in which atmospheric degradation has been at work that dome has been completely removed, the rivers gradually sinking to lower levels, but still continuing to flow outward as at first. Ramsay proclaimed his conversion to these views in the second edition of his book, which was issued in 1864. Next year there appeared the detailed essay on the subject by Dr. C. Le Neve Foster and the late Mr. Topley, which established beyond all further doubt the potency of atmospheric decay and river-erosion in the sculpture of the surface of this country.

The Huttonian doctrine, though thus long in gaining acceptance, made rapid progress when once a few enthusiastic workers, drawn under the spell of its attractiveness, began to apply it to the interpretation of all parts of the British Isles. In England and Wales, in Scotland and in Ireland, it gained every year an increasing number of followers, many of whom, with the usual geological alacrity, have contrived to pile up quite a respectable mass of scientific literature devoted to its discussion and promulgation. This great phalanx of observers and writers on the subject has now to hail as its latest recruit Lord Avebury, who has given another proof of his versatility by a contribution of more than 500 pages to a discussion of the origin of the scenery of England and Wales. Encouraged by the favourable reception accorded to his volume on the "Scenery of Switzerland," he has been led to produce another on that of his own country. Paradoxical as it may seem, it is nevertheless true that the task he set before himself in the preparation of this work was in many respects more difficult than that of the earlier publication. Notwithstanding the complicated structure of the Alps, the story of the origin of their valleys and the sculpture of their great blocks of mountain is on the whole less complicated and obscure than that of the tamer English landscapes. In this country the problems of topography involve questions of higher antiquity and lead the inquiry into a domain where the evidence is less distinct and abundant, and where a larger demand is made for detailed knowledge of the geological structure and history of the ground.

Lord Avebury devotes his earlier chapters to an outline of the geology of the country, and gives a brief account of the various rocks from the oldest to the youngest. In dealing with the scenery, he begins at the coast-line and notes the distinctive characters of our shores with the causes to which their variations are due. With regard to the interior, after some general statements respecting the movements of the terrestrial crust and their effects, he discusses the distribution, structure and origin of the mountains and hills, citing numerous examples from different parts of the country. He then passes on to the consideration of the rivers, dealing first with the general history of a typical river and illustrating his subject by references to the various English and Welsh streams by which the successive features of that history are best displayed. From moving water he naturally turns to the lakes, and picks his way with great skill among the rocks and shoals of that much-debated subject. The influence of the rocks in determining variations in the character of the landscapes is rapidly treated in a single short chapter, which is followed by one that probably gave him as much pleasure to write as any part of the book, for it deals with the downs, wolds, moors and commons which have been so familiar and delightful to him all his life. The next two chapters are not unlikely to have more interest for the unscientific reader than the rest of the volume, seeing that they treat of the connection of certain topographical features with old systems of land-tenure and methods of agriculture. They show why parish-boundaries run as they do and what causes have often determined the sites of towns. We are led across the country from one interesting historical spot to another, and are finally brought back to London and set to think of the geological reasons that have fixed the position of the chief city of the empire. It might, perhaps, have been better had the book appropriately ended there, but a final chapter is added in which, quitting the scenery and history of the Thames valley, the reader is suddenly plunged into the "nebular theory" and the tetrahedral collapse of the globe.

In his preface the author expresses a hope that the book may prove half as interesting to read as he has found it to write. Every reader must recognise the enthusiasm with which Lord Avebury has followed out his self-imposed task in a field which he had not made specially his own. He has brought together in readable compass a summary of what has been done in the investigation of the history of the scenery of England. Every here and there his narrative glows with the fervour of a true naturalist, as where he describes the shore-life of our coast-line with a minuteness which shows how closely he has observed, and with a breadth that brings the whole scene before us, or where he depicts the charms of the downs, noting their wild flowers one by one, and carrying us with him over their breezy crests, past green barrow and grey standing-stones. His book will doubtless do good service in attracting more general interest to one of the most fascinating branches of geology.

One feature of the volume gives it a special attraction. It is profusely provided with illustrations from photographs of English scenery, chiefly selected from the great collection which is gradually being gathered together by a committee of the British Association. We give two of them in this article, by way of examples (Figs. 1 and 2). Most of them have never before been published. But, beside the charm of novelty, they possess the still greater merit of having been taken, either by geologists or others, for the express purpose of preserving a record of interesting geological features. Those chosen for this volume have been excellently reproduced, and the printing of them is perhaps as near perfection as can be secured for illustrations that are printed with the general body of the type. The name of Messrs. Clark is a sufficient voucher for the beauty of the typography. But how did their reader or pressman allow the map (Fig. 183) to appear upside down?

Lord Avebury has not adopted the topographical nomenclature which our cousins on the other side of the Atlantic have devised and seem to be so proud of. Like other writers in this country, he has been able to treat his subject in plain English words, without recourse to a set of uncouth terms which are as unnecessary as they are undesirable.

The history of the landscapes of England, notwithstanding all that has been published on the subject, still presents many difficult problems for solution. Though Ramsay in his later papers so ably led the way, one great cause of stumbling to many of the workers in this field of inquiry still arises from their inability to realise the vastness of the denudation of the country within Tertiary and recent times. They shrink from the boldness of covering hundreds and thousands of square miles of ground with formations of considerable thickness, every vestige of which has disappeared. Yet it is only by conceding the former existence of such formations that they can possibly explain the present topography of the country and lines of drainage. The mere existence of an area of Palæozoic formations at the surface, especially, too, where it forms high land, ought to be regarded as in itself a proof that, for a vast period of time and until a comparatively late date, that area must have lain under a covering of later rocks. It was over this vanished,

covering that the present drainage system began to be traced, and the channels originally chosen by the streams that first flowed over it still, on the whole, keep to the same courses, though they have now cut their way down into the older rocks. The most helpful line of investigation that can at present be pursued in this subject is to be found in the search for actual or probable evidence of the extent of the denuded formations. The recent discovery by the Geological Survey of masses of Rhætic, Liassic and Chalk strata in a Tertiary volcanic vent in the Isle of Arran, which proves the former extension of these formations into the west of Scotland, is an example of the unexpected way in which the most important evidence may at any moment be discovered. But even if no such evidence should be forthcoming, it is impossible to contemplate the prodigious denudation of the country even among solid massive rocks like the lavas of the west of Scotland without the profound conviction that since Tertiary time hundreds of feet of rock have been removed from the surface, and that it is impossible to comprehend the history of our landscapes without taking this momentous fact into account.

THE ROYAL SOCIETY AND THE PROPOSED BRITISH ACADEMY.

THE following letter on this subject appeared in the *Times* of March 20 :—

To the Editor of the TIMES.

SIR,—In the references which have been recently made to the early history of the Royal Society, the charters of King Charles II. have frequently been remarked upon, and also the subject-matter of the communications published by the *Philosophical Transactions* from time to time. It has been conceded by many who have given attention to the matter that the charters of King Charles II. intended that the then newly-founded Society should take cognisance, not only of observational and experimental science, but also of those philosophical, historical and philological subjects for which, on the ground that they lack representation to-day, King Edward VII. has been petitioned to grant a charter enabling some new body to look after their interests. It has also been conceded that the early practice of the Royal Society was in accordance with the suggested intention referred to above, so far as the communications made to it enable us to form a judgment.

In a previous letter on this subject, which you were good enough to insert in the *Times* of January 29, I pointed out that a committee specially appointed by the Council of the Royal Society to consider the matter had reported, after consultation with high legal authorities, that the inclusion of the subjects within the scope of the Royal Society, for the general organisation of which it is now proposed to found a new Academy, is within the powers conferred on it by the charters of that Society. I venture to give two extracts from the first charter granted by King Charles II. which alone seem to establish this conclusion. If you will permit me, I will reproduce them here :—

Charles II., by the grace of God King of England, Scotland, France and Ireland, Defender of the Faith, &c., to all to whom these present Letters shall come, greeting.

We have long and fully resolved with Ourself to extend not only the boundaries of the Empire, but also the very arts and sciences. Therefore we look with favour upon all forms of learning, but with particular grace we encourage philosophical studies, especially those which by actual experiment attempt either to shape out a new philosophy or to perfect the old. In order, therefore, that such studies, which have not hitherto been sufficiently brilliant in any part of the world, may shine conspicuously amongst our people, and that at length the whole world of letters may always recognise us not only as the Defender of the Faith, but also as the universal lover and patron of every kind of truth : Know ye, &c.

Of the "Fellows" it is written :—

The more eminently they are distinguished for the study of every kind of learning and good letters, the more ardently they desire to promote the honour, studies and advantage of this Society . . . the more we wish them to be especially deemed fitting and worthy of being admitted into the number of the Fellows of the same Society.

Of course it would have been very much more satisfactory if the committee, instead of enunciating pious and legal opinions as to what the charters enabled the Society to do, as abstractedly as if the Society had never existed, had, seeing that action under the charters had been going on for nearly two centuries and a half, told us what the Society had really done year after year in the matter of choosing men for election into the Society. In this way sure proof could be obtained of the general opinion of what the charters empowered and enjoined the Society to do, not only at the time they were conferred, but at subsequent dates. This course, which obviously is the only satisfactory way of arriving at a conclusion on the questions at issue, was, however, not open to the committee ; for a complete list of the officers, Fellows and foreign members elected in each year from the foundation of the Society was not generally available.

This gap in our knowledge of the actual life of the Society has recently been filled, and we can now learn the kind of work for which the Society considered itself responsible by the men it elected to do it in its early days, and especially by those who were elected to fill the various offices. It will be obvious that a complete inquiry of this nature is a matter involving considerable time and labour ; but in the present state of the question raised by the proposition for a new British Academy it is of such high importance to know the facts that I have not hesitated to try to get at them, however imperfectly ; my inquiry being limited as much as possible, this has been done by passing over all doubtful cases and considering chiefly the first century of the life of the Society, that is from 1663.

The general result of this limited inquiry may be stated as follows :—

I begin with the presidents. Some were appointed on account of their rank, others on account of their contributions to observational or experimental science, among them Wren, Newton, the Earl of Macclesfield, and others. But besides these we have Sir John Hoskins, "a most learned virtuoso as well as a lawyer," according to Evelyn ; Samuel Pepys, of diary fame ; Martin Folkes, an antiquarian, "under whom the meetings were more literary than scientific" ; Sir James Burrow, an antiquarian, also a lawyer ; and James West, another antiquarian and collector of coins, and given to "black letter lore." If we pass the first century, we find Sir John Pringle, a learned physician and professor of metaphysics and moral philosophy, elected in 1772, and Davies Gilbert in 1827, who, although addicted to science, was chiefly an antiquarian and historian.

Among the treasurers we find one of the first appointed Abraham Hill, given as much to moral as to natural philosophy ; Roger Gale, an archæologist and numismatist ; and, again passing the first century, Wm. Marsden (1802), an Oriental scholar, and Samuel Lysons (1810), an antiquarian and an artist.

We next come to the secretaries. The most remarkable thing about these officers is that between 1663 and 1765, of the twenty-nine elected no less than sixteen were doctors of divinity, medicine or law ; and, so far as the inquiry has gone, the "Dictionary of National Biography" shows that they were not merely professional men, but scholars first and writers afterwards. The secretary elected in 1776 was Joseph Planta, the librarian of the British Museum ; while in 1812 Humphry Davy was followed by Taylor Combe, an archæologist and numismatist.

The office of foreign secretary was created in 1723. Of the eight appointed down to 1772, four were doctors of medicine, and they were selected possibly for the same reason as their colleagues among the secretaries. Maty, who was elected in 1772, was the assistant librarian in the British Museum.

The enormously wide area of knowledge from which the officers of the Society were drawn during the first century is in sharp antithesis to the narrow ground of award of the Copley medal, which was first conferred in 1731. The grant of this medal is limited to the author of the most important discovery or contribution to science by experiment or otherwise; and the greater the divergence between the officers' and Copley medallists' lists, the less, naturally, was the limitation of the Fellowship to those interested alone in experiment or observation.

We next come to the Fellows of the Society. The following lists are based upon a rapid reconnaissance of those who occur early in the alphabetical order, using Hole's "Brief Biographical Dictionary" as a means of determining their identity. The names of many Fellows are absent from Hole, and there are some incertitudes, besides which Hole's definitions are very terse. The lists, however, are given for what they are worth; and there can be little doubt that they will soon be replaced by complete and authoritative lists officially compiled. It is important that the Lords of the Privy Council should possess such documents to assist them in the important inquiry with which they are charged; and we may hope that this eagerness to possess is only equalled by the anxiety of the Royal Society to provide them if their compilation be in the interests of truth:—

Archaeologists and Antiquarians.

Ames, Josh.	1743
Amyot, Thos.	1824
Ashmole, Elias	1663
Astle, T.	1766
Ayloffe, J.	1731
Baker, G.	1762
Brander, G.	1754
Bridges, J.	1708
Churchill, Winston	1664
Gale, R.	1718
Gale, T.	1677

Writers.

Askew, Ant.	1749
Barrington, Daines	1767
Bathurst, Ralph	1663
Becket, Wm.	1718
Bentley, R.	1695
Birkenhead, J.	1663
Bowlden, T.	1781
Brocklesby, R.	1746
Brown, R.	1811
Bruce, J.	1791
Burnet, T.	1748
Burney, C. (Music)	1773
Cadogan, W.	1752
Chandler, J.	1734
Edgeworth, R. L.	1781
Egerton, F. H.	1781
Farmer, R.	1791
Green, T.	1798

Historians.

Abel, Clarke	1819
Barnes, Joshua	1710
Bates, G.	1663
Beaufort, Louis de	1746
Bernard, C.	1696
Birch, T.	1734
Clarke, J. G.	1792
Coxe, W.	1782
Duclos, C.	1764
Edwards, B.	1794
Ellis, G. A.	1816
Gillies, J.	1789

Philologists.

Colebrooke, H. T.	1816
Dickenson, E.	1677

Poets.

Akenside, Mark	1753
Browne, J. H.	1749
Byron, Lord	1816
Denham	1663
Dryden, J.	1663
Ellis, G.	1797

Travellers.

Bruce, James	1776
Brydone, P.	1773
Carteret, P.	1664
Chardin, J.	1682

Lawyers.

Adair, James	1788
Aland, J. F.	1711
Arden, R. P.	1788
Dalrymple, J.	1796

Although the matter has not as yet been inquired into, there is already ample evidence that the foreign members were selected with the same catholicity as the ordinary Fellows. Thus Sorbière, an eminent French *littérateur*, was elected in 1663 (the first year); the Italian historian Gregorio Leti was elected in 1681; and the French historian Michael Le Vassor in 1701.

It does not seem possible that any unprejudiced mind, after a perusal of the above statements, limited though they are to a point of time, and, in the case of the Fellows, to a few letters of the alphabet, and inaccurate as they may well be here and there, can deny that the reconnaissance affords valuable evidence that the action of the Royal Society for the first century after it had received its charters was as broad as the charters themselves. The Society tried to do, and succeeded in doing, the duty which the charters imposed upon it.

We learn from the above statements that for the period over which my hasty inquiry has gone, Britain possessed a general organisation of learning as complete, though not so detailed, as that of the Institute of France or any other foreign academy to-day. King Charles II. had, in fact, in his charters, and the Royal Society had, in fact, in its action upon them, anticipated the work of Napoleon by very nearly a century and a half; the portals of the Royal Society and of the Institute of France were equally wide, and wide enough to admit the most illustrious men produced in each country.

If I have erred in any way in reading the facts or in drawing conclusions from them, I sincerely trust that someone with more leisure and knowledge than I will discover where I have gone wrong and at once put the matter right. I am the more anxious that this should be done because I gather from the petition of the Royal Society Council to King Edward VII., which was printed in the *Times* of February 27, that the condition of things which the facts reveal is either unknown to the Council or regarded by them as a matter not worth mentioning.

In that petition His Majesty is informed that the President and Council are of opinion that the studies which it has been shown were fully provided for by King Charles II.'s charters to the Royal Society, and "taken care of" for, at all events, the first century to which my inquiry was limited, "ought to be taken care of by some academic organisation, and that this should be effected, not by the Royal Society taking charge of these studies, but by the establishment of some other body."

I submit, Sir, that the view that a complete inquiry should be made before any step be taken towards creating a new body to do what the charters of King Charles II. enjoined and empowered the Royal Society to undertake is vastly strengthened by the facts now brought to light, which show us what the Royal Society actually did.

This inquiry was thus referred to in the petition to the King, dated February 14, which was signed by many eminent representatives of the intellectual, industrial and other forces of the Kingdom:—

> We Your Petitioners humbly pray that Your Majesty may be graciously pleased to cause an inquiry to be made with a view of instituting a general and formal organisation of all the studies depending upon scientific method now carried on similar to that inaugurated for the philosophical studies of the seventeenth century by the charters of His Majesty King Charles II.

I, am, Sir,
Your obedient servant,
NORMAN LOCKYER.

Athenæum Club, March 11.

ANNOUNCEMENT OF NEW MAMMALIAN REMAINS FROM EGYPT.

THE discovery of ancestral Proboscidean and other remarkable mammalian forms in the Egyptian desert has already been noticed in NATURE (vol. lxiv. p. 582). Dr. C. W. Andrews's preliminary descriptions of the remains show that the deposits are of deep interest to palæontologists and other students of mammalian morphology and distribution. Mr. H. J. L. Beadnell now announces, in a pamphlet of two pages of text, illustrated by six plates, that explorations of the desert bounding the

Fayum depression have led to the discovery of several new creatures. "The most important of these," he says,

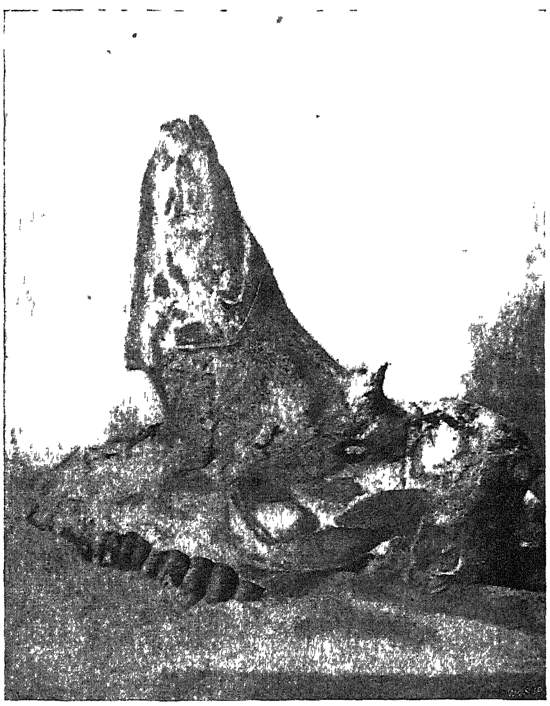


FIG. 1.—*Arsinoitherium Zitteli*, Beadn. Side View.

"is a large, heavily built, ungulate, about the size of a rhinoceros, and for which the writer proposes the generic

FIG. 2.—*Arsinoitherium Zitteli*, Beadn. Back View.

name Arsinoitherium, from Queen Arsinoe, after whom the Fayum was called in Ptolemaic times, the species being *A. Zitteli*, in honour of the eminent geologist, who may be regarded as the pioneer of geology in Egypt, and whose work when attached to the Rohlfs Expedition of 1873-74 is well known to all geologists." The accompanying illustrations, reproduced from the paper, show a side view (Fig. 1) and a back view (Fig. 2) of the type specimen.

BRYAN DONKIN.

BY the death of Mr. Bryan Donkin at Brussels on March 4 the engineering profession has lost one of its members who devoted himself with more than ordinary assiduity to the scientific side of his calling. The name of Bryan Donkin was eminent in the world of mechanical engineering for the whole of the last century. The late Mr. Donkin succeeded, in due course, to the management of the business which his grandfather, the first Bryan Donkin, had founded in 1803 for the manufacture of paper-making machinery; a new process for producing continuous rolls having been then recently introduced. Bryan Donkin, jun., as the subject of our memoir was known until quite recent times, was born in 1835, and was educated at University College, London, and at the École Centrale des Arts et Métiers in Paris, where he was for two years. After that he was apprenticed to his uncle at the Bermondsey works, his father, John Donkin, having died at a comparatively early age. In 1859 he went to St. Petersburg to superintend the erection of a large paper mill which was being established under the Imperial Russian Government for the manufacture of bank notes and State papers. He returned to this country and in 1868 became a partner in the Bermondsey firm. In 1889 the business was turned into a limited company, of which Mr. Donkin was chairman.

It was not, however, as the head of a manufacturing business that Mr. Bryan Donkin was best known in engineering circles, but as an experimenter and a student in thermodynamics and a reader of papers before technical societies. His first important work was undertaken in conjunction with Mr. Farey, who was also a partner in the Bermondsey firm. The latter had invented a steam-engine, which was known by his name, and it was determined that a complete test should be made to ascertain its efficiency. One of these engines had been erected to drive a paper mill in Devonshire, and the method of testing by measuring the heat discharged with the condensing water was adopted. The principles then followed are now well known, but thirty years ago scientific testing was a very rare thing among engine makers. The temperature of the water was naturally not difficult to ascertain, but to measure the volume with accuracy was a formidable task. How this was done by means of the notched weir and the application of a simple hydraulic law is too familiar to all engineers to need describing afresh.

Mr. Donkin carried on an extensive correspondence with continental engineers; probably he was more closely in touch with foreign scientific experts in the field of steam engineering than any of his compatriots. He devoted a great deal of attention to the use of superheated steam, and in the course of some experiments he devised an instrument he designated the "steam revealer." It consisted essentially of a glass vessel into which steam from the engine cylinder was admitted. By observing whether the steam was transparent or was clouded by the presence of watery vapour, it was possible to estimate if the steam were either superheated or saturated, or whether liquefaction had set in. A paper on this subject was read by its inventor before the Institution of Mechanical Engineers in October, 1900. Of late years Mr. Donkin devoted a good deal of attention to internal combustion motors. A book on "The Gas

Engine," which was from his pen, was published by Messrs. Griffin and Co. He also translated Diesel's work, "The Theory and Construction of the Rational Heat Motor." During the whole of his career he was constantly engaged in experiments of various kinds, one of the principal series being the tests he made, in conjunction with Prof. Kennedy, on the steam boiler. In 1898 a work which he had written on the subject was published by Messrs. Griffin and Co.

Mr. Donkin was a member of the Institution of Civil Engineers, from which society he received the Watt medal and Telford and Manby premiums; a vice-president of the Institution of Mechanical Engineers, and a member of various other scientific and technical societies.

NOTES.

M. YERMOLOFF has been elected a correspondant of the Section of Rural Economy of the Paris Academy of Sciences, in succession to the late Sir J. B. Lawes.

IN connection with the survey of British lakes provided for by the Pullar Trust, Sir John Murray has rented Rannoch Lodge, standing at the west end of Loch Rannoch, from now until the commencement of the shooting season. In the first week of April the following gentlemen will join him and will be associated with him in the work, viz., Mr. R. M. Clark, Aberdeen, Mr. T. N. Johnston, Edinburgh, Mr. James Parsons, London, and Mr. James Chumley, Edinburgh. Other appointments will be made later in the season. Sir Robert Menzies, who has taken a great interest in these investigations, and has placed boats, &c., at Sir John Murray's disposal for carrying on the work, has said that all Highland proprietors should render any assistance in their power to the survey by offering the use of boats. It is intended to include within the scope of the survey, in addition to the systematic physical and biological investigations, observations regarding the oscillations in the level of the water (phenomena called "seiches" by Prof. Forel) by means of self-registering "limnographs," which will be set up on the shores of the larger lakes. The first limnograph is now in process of construction in Geneva under the personal supervision of Prof. Ed. Sarasin, of Geneva. It will be remembered that Mr. Laurence Pullar, of Bridge of Allan, has set aside funds to aid in carrying out this survey, as a memorial to his son, the late Mr. Fred. P. Pullar, who was engaged (in collaboration with Sir John Murray) in a systematic survey of the Scottish lakes at the time of his accidental death in February of last year.

MR. J. HUTCHINSON, F.R.S., went to South Africa recently to study the local diffusion of leprosy there. The *Times* announces that he has now returned; and the conclusion to which he has arrived is that the primary cause of the disease is the use as food of badly-cured salt-fish. Whilst believing that this has been by far the chief agent in its diffusion, Mr. Hutchinson thinks he has obtained conclusive evidence that the malady may, in very exceptional circumstances, be communicated from person to person. He does not believe that it is either infectious or contagious in the proper sense of these words, but that it may be communicated by eating food contaminated by a leper's hands. The measures suggested for the prevention of the disease are, first (and by far the most important), the legislative control of the fish-curing establishments; secondly, the diffusion of information as to danger of communication; and thirdly, the establishment of small isolation homes into which lepers should be induced to go during the stage involving risk.

IT is stated that Prof. E. von Behring intends to give the amount of the Nobel prize recently awarded him (8400*l.*) to the Prussian State for the permanent endowment of the Institute of Experimental Therapeutics founded by him in the University of Marburg. The gift is to be devoted to the prosecution on a large scale of the researches on serum initiated by Prof. Behring. The *British Medical Journal* appropriately recalls the fact that several years ago Prof. von Behring gave the half of a French prize awarded to him, equivalent to a sum of 1000*l.*, in furtherance of serum research.

A NEW city branch of the Imperial Institute will be opened early in May for the display, to merchants, manufacturers, &c., of raw and manufactured products received, from time to time, from the colonies and from India, and for which it is desired to find openings in the British markets. Curators and other members of the Imperial Institute staff will attend at the office at stated times and by special appointment, to deal with inquiries and to assist in establishing or facilitating business relations with mercantile houses, &c., in the colonies and in India. The city branch will be in constant communication, by telephone and messengers, with the Imperial Institute, South Kensington.

EARLY in April, students of the Institution of Electrical Engineers will visit the Newcastle-on-Tyne district and inspect several works there. Among the places to be visited are the works and substations of the Newcastle Electric Supply Co. and of the Sunbeam Electric Lamp Co., the Elswick Works of Sir W. G. Armstrong, Whitworth and Co., the three-phase tramway system at Stockton-on-Tees, and the works of Messrs. Palmer's Shipbuilding and Iron Co.

WE are informed that at the meeting of the Connecticut Academy of Sciences on February 12, Prof. A. E. Verrill exhibited several remarkable photographs in natural colours taken direct from nature by a new process, just invented by Mr. A. Hyatt Verrill, of New Haven. One of these was a Bermuda landscape, in which the beautiful blue and green tints of the water, as well as the soft, creamy colour of the old stone Walsingham residence and the natural grey of the rocks, were well brought out. Three other plates were copies of water-colour drawings of groups of bright-coloured Bermuda fishes, taken from life by Mr. Verrill. The photographs were on paper, and were said to have been obtained by a purely photo-chemical process.

THE report of the council of the Scottish Meteorological Society, read at the general meeting of the Society on March 20, announces that the second volume of the Ben Nevis observations is approaching completion. This is the first of the three volumes, for the printing of which the Royal Societies of London and Edinburgh have each voted 500*l.* It contains the observations made at the Ben Nevis and Fort William Observatories from January 1888 to December 1892, and discussions connected with them. One of these discussions is by Mr. J. Aitken, F.R.S., on the dust of the atmosphere as observed on Ben Nevis and at various places in Scotland. For several years experiments with kites for meteorological purposes have been carried on near Edinburgh by Mr. John Anderson. He has now obtained a complete outfit, including an oil-engine of two and a quarter ($2\frac{1}{4}$) horse-power. It is proposed to test this kite, which in some respects has new features to recommend it, very thoroughly in the early summer. The outfit will be handed over to the ship of the Scottish Antarctic Expedition for use in the South Polar regions.

WE have received a reprint of a letter from Prof. A. Agassiz to Prof. E. S. Dana, dated Colombo, January 29, in which Prof. Agassiz announces the return of his expedition from an exploration of the Maldives, extending over several weeks. The general form of the plateau on which the atolls are situated has been determined and the channels between the lagoons carefully studied. The principal atolls in the middle of the group

are separated by shallow water, but towards the south the depths increase to nearly a thousand fathoms. Atolls are found in all stages of formation, including specimens of greater simplicity than have been found anywhere except on the Yucatan plateau. A preliminary report of the work will be issued as soon as the charts are completed.

IN a paper published by the Amsterdam Academy of Sciences, Prof. Eugene Dubois discusses the supply of sodium and chlorine by rivers to the sea. A large number of analyses of river-water are dealt with, and Prof. Dubois arrives at the conclusion that Sir John Murray's estimate of the amount of sodium delivered by rivers is much too high. The point is of special interest in relation to the attempts of Prof. Joly and others to estimate the age of the earth from chemical denudation. Prof. Dubois' results seem to indicate a period of the same order as that obtained by Lord Kelvin—twenty-four millions of years.

MR. J. BARCLAY, Birmingham, asks for an explanation of an effect he has observed, produced by refraction of air. While looking at a bookcase through the heated air rising from the chimney of a lighted lamp, the line of sight being a few inches above the top of the chimney, he noticed that one of the volumes appeared to project in front of the row in which it stood. Mr. E. Edser, to whom the observation has been referred, writes in reply:—"The illusion is obviously due to the refraction of light by a cylindrical column of heated air, which acts as a divergent cylindrical] lens. The refractive index of the air of the room may be taken, roughly, as equal to 1·0003. If the heated air rising from the chimney of the lamp has a temperature of 300° C., its refractive index would, roughly, be equal to 1·00015. At the interface between the cold and heated air, the effective refractive index would be equal to 0·99985. Assuming the lamp chimney (and therefore the column of heated air) to have a diameter of 1 inch, then the focal length of the cylindrical lens would be 0·00015. The distance of the book from the lamp was about 8 feet, or (say) 100 inches. Seen through the column of heated air, the distance v of the book from the lamp is given by the equation $1/v - 1/100 = 0{\cdot}00015$, from which v is found to be 99 inches. The book thus appears about an inch in front of its true position, as observed by Mr. Barclay."

WE congratulate our Norwegian contemporary, *Naturen*, on having completed the first quarter of a century of its struggle for existence in a country of only two and a quarter millions of inhabitants. It is published in Bergen, where it was founded in 1877 by Dr. Hans Reusch, then an assistant in the Geological Survey of Norway, of which he is now director. In spite of many difficulties, *Naturen* gradually gained ground at a time when old and excellent journals such as *Tidskrift for populaere fremstillinger* and *Naturen og mennesket* (both published in Denmark) were discontinued. In 1881 Dr. Reusch went abroad for some years and handed over *Naturen* to Herr Carl Kraft, who conducted it on the same lines and against the same difficulties until 1886. In January 1887 the journal became the property of the Museum in Bergen, which continued its publication under the editorship of its director, Dr. I. Brunchorst, and in 1893 it received a yearly Government grant of Kr. 1000 (= 55*l.* 10*s.* 3*d.*), on condition that 400 copies are supplied monthly at half price to State schools and public libraries, so that poorly paid teachers and others in remote districts may have access to its pages. In its first number for 1902, in which it celebrates the commencement of the twenty-sixth year of its existence, we are presented with the portraits of its first two editors. The number also contains articles by the three contributors to its first number in 1877, viz. Dr. H. Reusch, Herr I. Sparre Schneider and Prof. Geelmuyden. We wish the journal a long and prosperous life.

IN a lecture lately delivered before the Norwegian Geographical Society by Captain R. Amundsen, the author gave an account of the proposed exploring expedition to the magnetic North Pole. Captain Amundsen was first officer of the *Belgica*, which sailed for the Antarctic in August 1897 with the view of determining the exact locality of the magnetic South Pole, and it was while that ship lay fixed in the drift-ice west of Graham Land that the idea was conceived of exploring the magnetic North Pole. For the contemplated expedition, the *Gjöa*, one of the strongest and best sailing-vessels of the Arctic fleet, has been purchased at Tromsö. In 1831, Sir James Clark Ros reached a position where the dipping-needle was only deflected one minute from an absolutely vertical position, but the question has been raised whether the magnetic pole is actually only a point or whether the peculiarity of the needle assuming a vertical position extends over a large area, and, further, whether the magnetic pole changes its position. With the object of solving these two questions, Captain Amundsen will sail in the spring of 1903. The *Gjöa* is to be fitted with a petroleum engine and will carry a crew of seven men. A travelling magnetometer is under construction at the Deutsche Seewarte, and will resemble that used on board the *Fram*. A dipping-needle is being constructed in London, and will be examined at the observatory of the National Physical Laboratory. It is proposed to take magnetic observations as frequently as practicable, to leave the ship either at Matty Island or King William Land, and as soon as the severest part of the winter is over to continue the journey with the sledges to the place on Boothia reached by Ross.

WE have received a copy of Mr. C. E. Stromeyer's paper on explosions of steam pipes due to water-hammers, read before the Manchester Literary and Philosophical Society. The paper deals both with the causes of these explosions and with the forces which come into play when they occur. At the meeting Mr. Stromeyer made two sets of experiments with water in glass pipes. The first illustrated those accidents which are caused when the steam pipes are so arranged that water may find a lodgment over the boiler stop valve. When opening this valve, the steam pressure shoots the plug of water along the pipe until it strikes and shatters the engine stop valve, if this happens to be left partly open. The other experiment showed that if near the boiler stop valve there is an L pipe in which water can lodge while steam is in the main pipe above the vertical leg, then by draining away this water, which has, of course, to be done before starting the engine, steam is admitted to the horizontal leg and most violent steam-hammer blows occur, which have been the cause of many explosions. In the theoretical part of the paper, Mr. Stromeyer gives a proof that the velocity of a pressure wave is the same as the velocity of sound, which has an important bearing as showing that both undulatory and angular sound waves travel with the same speed. Then as regards the pressure exerted by an elastic body like water when it suddenly comes to rest, he explained that a pressure wave travels from the front end of the water column to the back end, and that the back end, or in fact any part of the water column, continues to move forward with its original velocity as long as it does not feel the wave of pressure. The arrested (pressed) water column is, therefore, shorter than the moving one. The ratio of the amount of shortening to total length is the ratio of original velocity (V) of the whole column to the pressure velocity (W). By multiplying this ratio by the elasticity of water (E) we get the pressure $P = E\,\dfrac{V}{W}$. Thus a plug of water only 6 inches long propelled through a distance of only 2 feet under a pressure of 15 pounds would on being suddenly arrested exert a pressure of 6400 pounds.

OUR contemporary the *Electrical Review* of New York celebrated on February 15 the twentieth anniversary of its publication. The greater part of a special issue is devoted to retrospective articles on the development of the different branches of the industry during the past twenty years. A facsimile reproduction of the first page of the first number shows that the original title of the journal was the *New York Review of the Telegraph and Telephone*, which sufficiently indicates the position of electrical engineering at that time. In 1882 the incandescent lamp was only just developed to a practical article; towards the end of the year the first central generating station was opened by Mr. Edison in New York. The first attempts at electric traction were just being made, and industrial electrochemistry had not advanced further than electroplating and a little copper refining. It has become, perhaps, hackneyed to remark on the rapid development of electrical engineering, but it is pleasant to be reminded occasionally in so striking a fashion how very great the rapidity has been. One of the most interesting features of the issue under consideration is the reproduction of engravings from early numbers showing some of the first commercial machines, and the comparison of these with the process blocks of the enormous engines and dynamos now in use. Altogether we can congratulate the paper on a very attractive and instructive number.

OWING to recent excavations in Hull, a large number of seventeenth century tobacco pipes have been discovered; these have been figured and described by Mr. T. Sheppard, the curator of the Hull Museum, in one of the useful penny guides, to another of which, on an ancient model of a boat, we drew attention a short time ago. This handbook will prove of value, as little is known about early clay pipes and their makers.

IN the thirty-fifth report on the Peabody Museum of American Archæology and Ethnology of Harvard University, we have a very satisfactory record of the research and field work accomplished during the year 1900–01. There were seven expeditions during that period to various parts of North and Central America for the purpose of studying languages, customs and archæology, and one graduate has done some valuable work in Syria. The collections have increased so greatly that the existing museum accommodation is quite inadequate; doubtless this will soon be remedied, as wealthy Americans are always ready to help deserving institutions that do their best.

WE have often drawn attention to the valuable *Bulletins* of the Madras Government Museum, and the current number (vol. iv. No. 2) fully sustains the reputation of the series. Mr. Edgar Thurston demonstrates an unexpected occurrence of brachycephaly among certain Dravidian tribes in the Bellary district of the Madras Presidency, where 37·8 per cent. (among 419 subjects examined) have a cephalic index of above 80, the average being 78·9 as opposed to an average index of 73·8 in the southern districts of the Presidency. We are pleased to find that Mr. Thurston will now study this problem. Mr. T. Ranga Rao is the author of an interesting paper on the Yánádis of the Nellore district (see p. 437), which was written as a thesis for the M.A. degree examination of the Madras University; in this recognition of ethnology the Madras University is in advance of those in the mother country. Among the "Miscellanea" are notes on the couvade, albinos, earth-eating, weighing beams, and other matters of interest pertaining to the ethnology of southern India.

NO. 6 of the *Sitzungsberichte* of the Vienna Academy for 1902 contains an abstract of the third part of Franz Baron Nopesa's work on the dinosaurian remains from Siebenburgen. This fasciculus is devoted to the description of the skull of the iguanodont known as Mochlodon, and also of dermal plates described under the name of Onychosaurus. In a second communication the author discusses certain European Cretaceous armoured dinosaurs, such as Struthiosaurus, Acanthopholis and Polacanthus, which he believes to be closely related to the remarkable horned Ceratopsidæ of North America.

IT is most satisfactory to learn, from an article contributed to the March number of the *Zoologist* by Mr. John Gurney, that spoonbills are making the mud-flats of Breydon Broad, Norfolk, their regular summer resort, from two to four of these beautiful birds having frequented this locality from the early part of April till the end of July. An avocet was also seen there on one occasion. These gratifying results are entirely due to protection; but Mr. Gurney adds that "unless the Breydon Wild Birds' Protection Society receives more pecuniary support than it has had in the past, it will be unable to continue to carry on its good work." In a rich county like Norfolk there ought to be no difficulty in obtaining the necessary funds. Out of the fifteen Spanish bustards turned down near Thetford in 1900, only two pairs remain, and these wandered on one occasion nearly as far as Newmarket. Among rare birds recorded in Norfolk during the past year, Mr. Gurney mentions the golden oriole, orange-legged hoby, woodchat, roller, Tengmalm's owl and Caspian tern.

IN his address to the thirteenth annual meeting of the Association of Economic Entomologists, held at Denver, Colorado, in August last (of which a report appears in *Bulletin* No. 31 of the Entomological Division of the U.S. Department of Agriculture), Mr. G. P. Gillette took for his subject the life-history of the codling-moth. One of his objects was to show the imperfection in our knowledge of the history of even the most common insects; and since, next to the "two-lined locust," the codling-moth is the species which occasions the greatest loss to cultivators in Colorado, the importance of a full knowledge of its habits can scarcely be overrated. Until quite recently, entomologists held the belief that the moth lays its eggs in the calyces of apples; the fruit-growers knew this to be an error, and in consequence have, unfortunately, somewhat lost confidence in the work of the Division. A special subject of investigation has been the number of broods annually produced by this insect. In Colorado, where the species is definitely known to be double-brooded, the habits of the moth are probably very different from those in the more eastern districts, and one of the main objects was to determine whether in the warmer parts of the country, where more tender fruits are grown, the annual number of broods might not be greater.

MESSRS. BLACKIE AND SON contemplate a re-issue of Kerner's "Natural History of Plants," a work which in its English form is identified with the name of Prof. F. W. Oliver. The new edition, which will be issued at a considerably reduced price, will be substantially a reprint of the original English edition, with a few necessary alterations and corrections.

THE "Class List and Index of the Periodical Publications in the Patent Office Library," lately published by the Patent Office (Bibliographical Series, No. 5), is a well-arranged catalogue of journals, reports and other periodical publications of interest to students of pure and applied science. The reports of scientific and polytechnic societies and the scientific and technical journals are subdivided locally; they are also classified according to subjects. There are in the list 2563 works, distributed under 356 classes and representing about 39,680 volumes.

TWO catalogues of scientific apparatus which have recently been received show that the needs of teachers and investigators of physical science are well supplied by instrument makers. One

of the catalogues shows apparatus made by Messrs. J. J. Griffin and Sons for the purposes of instruction in sound, light and heat in schools and colleges. Among the new and ingenious devices contained in the catalogue we notice simple apparatus for the determination of the coefficient of linear expansion, the determination of relative conductivities, and a model theodolite. To make the catalogue of permanent use in the laboratory, tables are given of physical constants frequently required, and of logarithms, anti-logarithms and trigonometrical functions. The new catalogue of physical and electrical apparatus made by the Cambridge Scientific Instrument Company contains many instruments of precision not found in the lists of other instrument makers. For instance, a comparator and cathetometer combined, which can be used in a vertical or horizontal instrument, is described in the catalogue, and also geometric tripod stands, which can be so arranged as to form a stand of any desired height. Both these appliances were designed by Prof. C. V. Boys, and have not been illustrated previously. Other noteworthy instruments are a chronograph for laboratory use and the "Cambridge" standard coils, which are wound with bare platinum silver wire round a stout mica frame supported by a brass carrier. The coils are contained in a glass case with an ebonite top and are immersed in insulating oil. This arrangement ensures the coil being at the true indicated temperature, as there is no lagging due to paraffin wax or silk covering.

THE additions to the Zoological Society's Gardens during the past week include a Wedge-tailed Eagle (*Aquila audax*) from Australia, presented by Mr. Aubrey Richardson; two Spotted Turtle Doves (*Turtur suratensis*), a Barred Dove (*Geopelia striata*) from India, presented by Mr. L. Ingham Baker; a Common Bluebird (*Sialia wilsoni*) from North America, presented by Miss L. B. Dyar; five Prjevalsky's Horses (*Equus prjevalskii*) from Northern Mongolia, an Egyptian Jerboa (*Dipus aegypticus*) from North Africa, a Raven (*Corvus corax*), a Lapwing (*Vanellus vulgaris*), European, a Red-fronted Amazon (*Chrysotis vittata*) from Porto Rico, a Lesser Sulphur-crested Cockatoo (*Cacatua sulphurea*) from Moluccas, two Californian Quails (*Callipepla californica*) from California, five Yellow-winged Sugar-birds (*Coereba cyanea*), three Brazilian Tortoises (*Testudo tabulata*) from South America, a Long-necked Chelodine (*Chelodina longicollis*), a Bearded Lizard (*Amphibolurus barbatus*), a Gould's Monitor (*Varanus gouldi*), a Lace Monitor (*Varanus varius*) from Australia, twenty-four sharp-headed Lizards (*Lacerta dugesi*) from Madeira, deposited.

OUR ASTRONOMICAL COLUMN.

ASTRONOMICAL OCCURRENCES IN APRIL.

April 2. 4h. Saturn in conjunction with moon. Saturn 5° 15′ S.

3. 9h. Jupiter in conjunction with moon. Jupiter 5° 53′ S.

4. 8h. 46m. Minimum of Algol (β Persei).

8. Sun eclipsed, invisible at Greenwich.

9. 15h. 51m. to 20h. 35m. Transit of Jupiter's Sat. IV.

10. Saturn. Outer minor axis of outer ring = 13″·96.

10. 16h. Ceres in conjunction with moon (Ceres 0° 23′ N.).

11. 9h. 36m. to 10h. 15m. Moon occults δ^3 Tauri (mag. 4·2).

12. 11h. 23m. to 12h. 11m. Moon occults 119 Tauri (mag. 4·6).

14. 12h. 36m. to 13h. 9m. Moon occults 68 Geminorum (mag. 5·0).

15. Venus. Illuminated portion of disc = 0·435, of Mars = 1·000.

15. 11h. 47m. to 12h. 17m. Moon occults 27 Cancri (mag. 5·6).

21. 11h. 46m. to 12h. 52m. Moon occults α Virginis (mag. 1·2).

April 22. 5h. 0m. to 8h. 45m. Moon eclipsed, partly visible at Greenwich. Moon rises at 7h. 5m. totally eclipsed.

23. 12h. Mercury in conjunction with Mars. Mercury 0° 40′ S.

23. 12h. 30m. to 16h. 12m. Transit of Jupiter's Sat. III.

24. 10h. 28m. Minimum of Algol (β Persei).

25. 10h. 53m. to 12h. 7m. Moon occults B.A.C. 5580 (mag. 5·7).

25. 12h. Venus at greatest elongation, 46° 12′ W.

26. 10h. 51m. to 15h. 40m. Transit of Jupiter's Sat. IV.

28. 16h. 20m. to 17h. 44m. Moon occults ρ^1 Sagittarii (mag. 3·9).

29. 14h. Saturn in conjunction with moon. Saturn 5° 20′ S.

ORIGIN OF DISTURBANCE IN CORONA, MAY 17–18, 1901.—*Bulletin* No. 18 from the Lick Observatory is devoted to the discussion of more detailed examination of the photographs obtained during the total solar eclipse in Sumatra, which showed evidence of a marked disturbance in a certain region of the corona. A set of positives on glass from solar negatives taken at Dehra Dûn, India, for the Solar Physics Committee, have since been received from the Astronomer Royal, giving exact records of the solar surface on May 17, 18, 19, 20, 21, 22, 26 and 28, 1901. The photographs of May 17 and 18 show no evidence of spots or other active features, but that for May 19 shows a medium-sized spot just passed into view round the east limb. On the 20th, this is seen to be followed by a group of smaller spots, surrounded on all sides except the west by a large area of faculæ. This group of small spots shows conspicuous changes from day to day.

The positions of the spot on the plates of May 19 and 28 were measured, and from the reduced values its probable position on the day of eclipse was computed. It would be on the opposite side within 4° of the limb. The position angles of the spot as projected on the limb and the apex of the coronal disturbance are practically identical. As, moreover, both the sunspot and the coronal disturbance appear to have had the same latitude, it can hardly be doubted that this unusual appearance in the corona was in reality immediately above the group of sunspots and faculæ, and that it had its origin in the same disturbance of the solar surface. In view of this conclusion, an attempt was made to determine if any measurable displacement of any of the coronal masses had occurred during the interval of about five minutes, but no certain indication of such motion could be detected. In this connection, however, the interval of one and a half hours between the times of eclipse in Mauritius and Padang should render a comparison of the negatives secured at the two stations valuable.

FOUCAULT'S PENDULUM.—An interesting announcement is made in the March number of the *Bulletin de la Société Astronomique de France* to the effect that a movement is being started among the astronomical authorities in Paris to arrange for the repetition of Foucault's famous experiment at the Panthéon, which was interrupted in 1851. No definite arrangements are yet settled, but it is hoped this majestic demonstration of the rotational movement of the earth will be successfully installed with all the advantages of modern refinements in instrumental construction.

A CONVENIENT TERMINOLOGY FOR THE VARIOUS STAGES OF THE MALARIA PARASITE.[1]

I HAVE found it necessary in labelling a series of models of the malaria parasite in the Central Hall of the Natural History Museum to use as simple and clear a terminology as possible. I think that this terminology will be found useful by others who are perplexed by such terms as "sporozoites," "blasts," "ookinetes," "schizonts," "amphionts" and "sporonts"—terms which have their place in schemes dealing with the general morphology and life-history of the group Sporozoa, but are not, as experience shows, well suited for immediate use in describing and referring to the stages of the malaria parasite.

It is necessary to treat the malaria parasite from the point of view of malaria; that is to say, to consider its significant phases

[1] By Prof. E. R. Lankester, F.R.S. Read before the Royal Society on March 6.

to be those which it passes in the human blood. In reality its mature condition and most important motile, as well as its most prolific reproductive, phases are passed in the body of the mosquito.

(1) The malaria-germ which is brought by the stab of the Anopheles into the human blood-vessels is a reproductive particle, a *spore*. It is needle-like in shape, and might be named in reference to its form (*e.g.* oxyspore or raphidiospore), but the most important fact about it for description and comparison is that it has been formed *outside* the human body, and is introduced as a strange element into the human blood by the agency of the mosquito. I therefore call it the EXOTOSPORE.

(2) The Exotospores (probably as many at a time as forty or fifty) enter the blood by the agency of the mosquito's stab and immediately penetrate, each one, a red corpuscle. The history of this process has not been observed. As soon as it has entered a red corpuscle the exotospore loses its needle-like shape and becomes amœbiform. I apply to it the name I proposed some years ago for similar amœbiform spores in other Protozoa, namely, AMŒBULA ("Encyclopædia Britannica," article "Protozoa").

(3) The Amœbula exhibits amœboid movements within the red corpuscle, enlarges and finally breaks up into spherical spores, which are liberated with destruction of the red corpuscle. It seems to me unnecessary to have a special name for the star-like or other condition of the Amœbula when in course of breaking up into spores; but the spores so produced require a special name which shall emphatically distinguish them from the Exotospores. I call them the ENHÆMOSPORES, in reference to the fact that they are produced by a process of division which occurs *in* the blood of the malaria-stricken human being.

(4) The Enhæmospores penetrate fresh red blood-corpuscles, and after a certain growth as amœbulæ break up into a new crop of Enhæmospores, by which the infection of the red corpuscles is extended. This process appears to go on for several generations and for a varying duration of time. But owing to conditions and at a period of the infection which has not been precisely ascertained, some (or all?) of the amœbulæ derived from Enhæmospores cease to break up into spores. Instead of carrying out that process they enlarge, and in the case of the æstivo-autumnal parasite (*Laverania praecox*) become sausage-shaped or, as it has been termed, crescent-shaped. This change of form is accompanied by a destruction of the red corpuscle and the formation of granules of dark pigment within the parasite. It seems best to term this phase the "CRESCENT" or "CRESCENT-SPHERE," the latter term being applicable to those species in which the form is not markedly crescentic.

(5) The crescents or crescent-spheres remain quiescent in the human blood. They are, however, of two different natures—male and female. It is not possible to distinguish with any certainty the male from the female crescents whilst they remain in the human blood-vessels. But it is these bodies which are destined to be swallowed by the Anopheles mosquito and to carry on further the life-history of the parasite.

The crescents are therefore the sexual phase of the parasite. When the crescents are swallowed by a mosquito (of an appropriate species), they undergo two different modes of development, determined by the fact of their sex. Both sexes become spherical, and may now be called respectively "EGG-CELL" and "SPERM-MOTHER-CELL."

From the periphery of the SPERM-MOTHER-CELL, now floating in the mosquito's stomach, there are developed with surprising rapidity six or seven SPERMATOZOA, which for a time remain attached to the residual mass (or SPERM-BLASTOPHOR) of the sperm-mother-cell. Complete cytological study of this development is still wanting, but it appears that the spermatozoa are true spermatozoa, like those of the higher animals, and have the same relation to the mother-cell from which they develop as is the case in such an animal as the earth-worm.

The EGG-CELL, now also floating in the mosquito's stomach, apparently gives rise to one, and possibly to two, polar bodies, but the observations on this point are, as yet, insufficient.

Fertilisation of the egg-cell now takes place in the gnat's stomach. A single spermatozoon penetrates and fuses with each egg-cell.

The fertilised egg-cell is spoken of as a "zygote"; it is also described as the sexually produced embryo.

(6) The ZYGOTE OR SEXUALLY PRODUCED EMBRYO remains unicellular, but increases in size and becomes pyriform. It exhibits active movements of expansion and contraction in the line of its long axis, and also a quick movement of its narrower end alternately to either side. This is the largest growth of the individual cell attained to in the series presented by the life-history of the malaria parasite. It has been called "vermiform" and "vermicule" (Ross), and I adopt this name for it, viz. the VERMICULE. The vermicule is the dominant individual form in the history of the malaria parasite, endowed with greater size, power and activity than other phases. It corresponds, not only in this respect, but also in its position in the life cycle, to the large often active cells of the Gregarinidea, which I proposed some time ago to call the Euglena-phase ("Encyclopædia Britannica," article "Protozoa").

It is worthy of note that in the size and activity of the vermicule, the Hæmaosporidia—the order of Sporozoa which embraces the malaria parasite—come nearer to the Gregarinidea than they do to the Coccidiidea, though in the existence of a sexual generation absent in Gregarinidea they agree with the Coccidiidea.[1]

The vermicule now pushes its way through the tissues of the gnat's stomach and in the blood sinuses outside the stomach becomes spherical. It enlarges and nourishes itself on the insect's blood, and forms a spherical CYST, or structureless transparent envelope. This cyst is destined to enlarge, with vast increase of its living contents.

The living cell within the cyst breaks up by a definite process to form eventually an immense number of exotospores, the stage with which the present description commenced. The CYST would most conveniently be called a "sporocyst," since, as so often happens in Protozoa, it is formed purely and simply in relation to the quiescence of the organism and its division into numerous reproductive spores. Unfortunately, the word "sporocyst" has been employed recently by writers on the Sporozoa for the small capsules containing one or two to eight elongated spores which used to be called "pseudonaviculæ," and are formed *within* such larger cysts as that now in question. The word "cyst" should have been reserved for the larger more general protective envelope, and the "pseudonaviculæ" might have been called "sporo-thekæs." In any case, I think we may call the cysts in which the vermicules of the malaria parasite enclose themselves "SPORE-CYSTS" or "SPORE-FORMING CYSTS." The name "oocyst," applied to them by some writers, is simply misleading.

(7) The spore-cysts lying outside the stomach wall of the mosquito bathed in the insect's blood receive abundant nourishment. The single-celled vermicule enclosed undergoes rapid changes; it increases greatly in volume and breaks up by normal cell division (? the earliest steps have yet to be studied) into a number of SPORE-MOTHER-CELLS. In the process of this division and the later stages of the final development of the "spores" (exotospores), the "spore-forming cyst" increases in size to twenty times its initial diameter.

The spore-mother-cells are set closely together in the cyst; they are of polygonal shape, owing to pressure, and each has its nucleus. Finally they give rise, each spore-mother-cell, to a crop of filiform spores (exotospores) which have the same relation to the spore-mother-cell as spermatozoa have to a sperm-mother-cell, viz., they form on the outside of the spore-mother-cell as outstanding processes, carrying away all the chromatin of the mother-cell and leaving in the centre or to one side a "residuary body," a "spore blastophore" similar to the "sperm-blastophore" of spermatozoon-development.

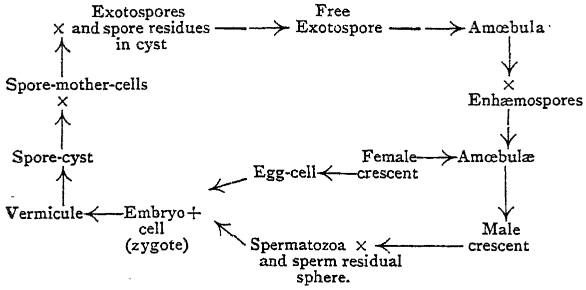
Thus we are brought back to the needle-like exotospores with which we started.

The spore-holding cysts burst and liberate the exotospores into the blood of the mosquito. Thence they readily pass into the ducts of the salivary gland, and so are conveyed by the mosquito's stabbing beak into human beings. A point in this connection is the definite ejection by the mosquito of the secretion of its salivary gland into the punctured wound which it makes in the human skin. There can be no doubt that such an ejection takes place. The leech ejects a secretion on to the wound caused by its bite which has the property of preventing the coagulation of the blood. It is possible that the mosquito and other blood-sucking flies may use the salivary secretion for the same purpose. It is obvious that unless there were some injection into the wound on the part of the fly, the chances of

[1] A sexual phase has been described in the Gregarine Stylorhynchus by Léger since this paper was written. It occurs at an unexpected point in the cycle: two encysted full-grown "Sporonts" are stated to produce the one egg-cells the other spermatozoids.

infection of the bitten animal by the parasites carried by mosquitoes or tzetze fly would be very small.

Our cycle of forms with the names here made use of may be written as below. The sign × is used to indicate fissile multiplication, and + to indicate fusion, while → merely indicates continuity.



I also give a list of the names here used with reference to the occurrence of the forms indicated in man or in gnat and an indication of the corresponding stages in a Gregarina and a Coccidium. In the column belonging to Coccidium I have employed the generalised physiological nomenclature accepted by special students of the Sporozoa (Schaudin, Lühe, &c.).

power will be given to have that limit raised by provisional order. Boroughs already possess a certain jurisdiction over technical education, and have a rate of 1*d.* to work upon. It is not proposed to deprive any borough with a population above 10,000, or any urban district with a population above 20,000, of that jurisdiction. The councils of these boroughs and urban districts may, if they choose, become the absolute authority over primary education. They would retain their existing powers over technical education, and would become the authority for secondary education concurrently with the county council. But whether the schools in a district are voluntary or rate erected, the local educational authority created by the Bill will in future be the absolute master over all secular education. London is excluded from the operation of the Bill. The adoption of the elementary education portion of the measure would, for a time, be optional.

MR. H. BRERETON BAKER, M.A., late scholar of Balliol College, Oxford, has been elected by the governors of Dulwich College to be headmaster of Alleyn's School, Dulwich. Mr. Baker, who has had several years' scholastic experience as senior science master in Dulwich College, is well known as a chemist of real distinction, whose important papers in the *Philosophical Transactions* and the *Journal* of the Chemical Society on the remarkable influence of traces of moisture in facilitating chemical action have attracted well-deserved attention. Physical science has long formed a prominent part of

Malaria.	Coccidium.	Gregarina.
1. Exotospore, free in human blood ... ... ("Blast" of some authors.)	Sporozoite	Sporozoite. (Filiform young.)
2. Amœbula, in red corpuscles	Schizont	Amœbula.
3. Enhæmospore, ditto, and in blood	Merozoites, formed by schizogony.	
4. Crescent, in human blood	Gametocytes	
a. Male	Microgametocyte	
b. Female	Macrogamete	Schizogony rare; sexual stages NOT OBSERVED and probably WANTING.
5. Sperm-mother-cell, in gnat's stomach	Microgametocyte	
6. Egg-cell, in gnat's stomach	Macrogamete	
7. Spermatozoon, in gnat's stomach	Microgamete	
8. Zygote or embryo-cell, in gnat's stomach	Young oocyst (sporont)	
9. Vermicule, in gnat's stomach	WANTING ... ... (Called "ookinete" or "kinetosporont" in the nomenclature of this column.)	Full-grown motile "gregarine." (Euglenoid phase.)
10. Spore-cyst, in blood-sinus outside gnat's stomach	Older (but not larger) oocyst or sporont	Cyst enclosing one or two full-grown sporonts.
11. Spore-mother-cells in cyst, in blood-sinus outside gnat's stomach	Sporoblasts (sporogony)	Sporoblasts. (? Conjugation in *Lankesteria Ascidiae.* Spermatozoa and ova in Stylorhynchus.)
12. Exotospores in cyst, in blood-sinus outside gnat's stomach	Sporozoites enclosed in small groups in sporocysts within the bigger oocyst.	Sporozoites enclosed in capsules, called "pseudonaviculæ" or "sporocysts."
21. Free exotospores, in gnat's salivary duct	Free sporozoite	Free sporozoite.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

THE proposals of the Government with respect to education in England and Wales were described in the House of Commons by Mr. Balfour on Monday, and after a discussion, leave was given for the introduction of the Government Education Bill. It is proposed that in future there shall be one authority for education, primary, secondary, and technical; and that this authority, being responsible for a heavy cost to the ratepayers, shall be the rating authority for the district. Explaining the broad outlines of the measure, Mr. Balfour stated that the education authority will be the county council in counties and the borough council in county boroughs. They will work through committees appointed under schemes which will have to be approved by the Education Department. A majority of a committee at least is to be appointed by the council. The other members are to be nominated, and to be persons experienced in education. Wales, which has a secondary education authority already, is to be permitted either to retain that authority or to substitute for it the authority proposed in the Bill. With regard to secondary education, the provisions of the measure are practically identical with those embodied in the Bill of last year. County councils and borough councils are to have a 2*d.* rate to work upon, and as in many places that will be insufficient,

the course at Alleyn's School, which possesses physical and chemical laboratories that are probably not surpassed by those of any school in the country It will be a matter of interest to scientific men that at least one school in the kingdom should be, not only well provided with laboratory accommodation, but should have at its head a man of acknowledged scientific reputation.

SIR PHILIP MAGNUS will preside at a public meeting to be held in connection with the conference of the National Association of Manual Training Teachers at Manchester on Easter Tuesday, April 1.

THE Government of India has had under consideration the improvement of the existing system of education of Europeans and Eurasians, and the Local Governments have been asked for an expression of their views upon the subject. Meanwhile (says the Allahabad *Pioneer Mail*) a small committee of educational officers has been appointed to examine and revise the Bengal Code of Regulations for European Schools, in the hope that it may be found possible to render it suitable for adoption throughout India. The Secretary of State has accepted the proposal of the Government of India to create an appointment of Director-General of Education in India, and Lord George Hamilton has selected Mr. H. W. Orange to fill the post.

AT a meeting of the Edinburgh Mathematical Society on March 14, the following resolutions in regard to the teaching of elementary mathematics were agreed to:—(1) That the primary object in teaching elementary mathematics is to afford a mental training to the pupil. The commercial, technical or professional applications of the subject are of secondary importance in general education. (2) That there should be no undue haste to begin the study of the calculus with a view to its practical applications. (3) That pupils should not be encouraged in the unscientific practice of placing dependence on rules or formulæ which they do not understand. (4) That, in teaching any branch of mathematics, concrete illustrations and verifications including experimental, graphical and other methods should, wherever practicable, accompany theory. (5) That in examinations particular methods of solution or demonstration should not, as a rule, be demanded, *e.g.*, the use of algebra should not be prohibited in answering questions in arithmetic or geometry. (6) That there should not be imposed upon schools in any branch of mathematics a syllabus which does more than indicate the order in which the main divisions of a subject are to be taught.

DR. D. C. GILMAN'S reminiscences of the foundation and early days of the Johns Hopkins University, given in the current number of *Scribner's Magazine*, contain several interesting particulars concerning men connected with it. Johns Hopkins left his fortune to be divided between a university and a hospital, the two to be united in the promotion of medical science. As the capital for the university was thus provided by a single individual, there were no bodies to interfere with its plans, and no public or treasury to conciliate. Given the idea and the funds, all that had to be done was to produce the plan of an institution which should aim at having national influence, and should take to Baltimore, as teachers and students, the ablest minds that could be attracted there. Rowland was an assistant instructor in the Rensselaer Polytechnic Institute when Dr. Gilman heard of him from General Michie, and the following conversation occurred:—"What has he done?" I said. "He has lately published an article in the *Philosophical Magazine*," was his reply, "which shows great ability. If you want a young man you had better talk with him." "Why did he publish it in London," said I, "and not in the *American Journal?*" "Because it was turned down by the American editors," he said, "and the writer at once forwarded it to Prof. Clerk Maxwell, who sent it to the English periodical." When Dr. Gilman had seen Rowland and reported upon his rare powers to the trustees in Baltimore they said at once, "Engage that young man and take him with you to Europe, where he may follow the leaders in his science and be ready for a professorship." This was done; and the result is well known. Huxley gave the inaugural address, but he had to deliver it from memory, as he could not read the flimsies with which the reporters to whom he had dictated the lecture on the previous day had provided him. After this opening without music, prayer or other benediction came the storm of indignation from the religious papers. Referring to the opening, a Presbyterian minister wrote to a friend:—"It was bad enough to invite Huxley. It were better to have asked God to be present. It would have been absurd to ask them both. I am sorry Gilman began with Huxley. But it is possible yet to redeem the University from the stain of such a beginning." It took some years for the prejudice to wear away, but eventually the idea of an undenominational university controlled by laymen was accepted as reasonable, and Johns Hopkins' foundations became renowned as places of freedom and progress.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, January 30.—"The Distribution of Magnetism as Affected by Induced Currents in an Iron Cylinder when Rotated in a Magnetic Field." By Ernest Wilson, Professor of Electrical Engineering, King's College, London. Communicated by Sir W. H. Preece, F.R.S.

One object of this research was to investigate the effect which induced currents have upon the distribution of magnetism in an iron cylinder when rotated about its longitudinal axis in a magnetic field, the direction of which was normally at right angles to the axis of rotation. The variables dealt with were the total flux of magnetism between the poles of the magnet, and the speed of rotation of the cylinder. By threading insulated copper conductors through holes drilled in a plane containing the longitudinal axis, E.M.F.'s due to the rate of change of induction at different depths have been observed, and therefrom the intensity of induction has been found. The cylinder had a diameter of 25·4 cms., and its length was 25·4 cms. It was rotated by aid of a worm and worm wheel. Periodic times of 360, 180, 90, 45 and 22·5 seconds have been dealt with, and the normal induction density B in the cylinder has been varied from about 170 to 21,000 C.G.S. units per sq. cm.

With small magnetic force, and a periodic time of 45 seconds, the value of B at the centre of the cylinder is important as compared with its value at the surface, and the phase-displacement between the two is relatively small. With intermediate magnetic force, corresponding to high average permeability in the iron, the value of B at the centre became relatively small, accompanied by considerable phase-displacement. In fact, with 22·5 seconds periodic time, B at the centre was totally reversed in sign with regard to B at the surface, or the lag was 180°. With large magnetic force, B at the centre again became important, and the phase-displacement was again small. With a periodic time of 360 seconds, the disturbances above described still existed, but they were small. Similar effects to the above were observed in the case of an iron cylinder subjected to alternating magnetic force.

The conclusion was that with an alternating magnetic force applied axially to a cylinder of given diameter, the effects were more severe than in the same cylinder (of length equal to diameter) when rotated in a magnetic field as above described at the same frequency, and for corresponding values in the surface induction density. The results of these experiments were applied to similar cylinders of different dimensions by an application of the law of squares. The effects of induced currents in the armature of a certain class of induction motor were dealt with. It is shown that plates of iron 0·1 cm. thick experience no serious deviation from uniform distribution when rotated in a magnetic field, the direction of which was in the plane of the plate, at frequencies lower than about 180. Referring to Lord Kelvin's computation that the earth's magnetism is travelling round the earth in the direction of the sun with a periodic time relatively to the earth of 960 years, it is pointed out that in a cylinder similar in all respects to the one experimented upon, but having a diameter equal to that of the earth, a periodic time of 960 years would produce similar magnetic and electric events as would be observed in the above cylinder if it could be rotated with a periodic time nearly two million times as fast as the fastest speed in these experiments. On the other hand, with a cylinder 0·0000001 cm. diameter, 7×10^{14} revolutions per second would be required to produce the disturbances observed in these experiments.

March 6.—"The Differential Equations of Fresnel's Polarisation-vector, with an Extension to the Case of Active Media." By James Walker, M.A. Communicated by Prof. Clifton, F.R.S.

In many problems of optics we require the differential equations that the polarisation-vector has to satisfy, and the surface conditions that subsist at the interface of different media. These may be deduced from the principle of interference combined with the experimental laws of the propagation of light, without making any assumption respecting the character of the ether and the nature of the luminous vibrations. In crystalline media, Fresnel's theorem of the ellipsoid of polarisation affords the required relations between the wave-velocity and the directions of the wave-normal and of the polarisation-vector; in the case of active media, extensions of this theorem lead to similar equations giving the wave-velocity in terms of the direction-cosines of the wave-normal and the complex direction-cosines of the vector of a stream of elliptically polarised light. The differential equations are then deduced by applying the principle of interference. The surface conditions are obtained by assuming that the transition between two media takes place by a rapid continuous change of their properties and that the differential equations hold within the region of variation.

Royal Astronomical Society, March 14.—Dr. J. W. L. Glaisher, president, in the chair.—The secretary read a paper by Dr. Mitchell, of New York, on the flash spectrum at the Sumatra eclipse of May, 1901. Mr. Fowler gave reasons for doubting the correctness of Dr. Mitchell's view that the flash spectrum represents the upper portion of the layer of gas which, by absorption, gives the Fraunhofer lines.—A paper by Prof. Barnard on Nova Cygni, 1876, was partly read.—Mr. Maw presented a series of double star measures made by him in the

years 1899–1901.—The Astronomer Royal presented a paper on new variable stars found at the Royal Observatory during the measurement of plates for the Astrographic Catalogue, and also a series of measures of double stars made at Greenwich with the 28-inch refractor. Prof. Turner described an instrument for rapidly comparing two star plates of the same region, and Mr. Lewis spoke upon the orbit of δ Equulei.—Mr. Maunder gave an account of a paper from the Royal Observatory on the mean areas, &c., of sun-spots in the year 1901, and referred to the apparent connection between the large sun-spot of May 1901 and the disturbed portion of the corona as shown on the eclipse photographs.—Mr. Dyson gave a summary of a paper from the Royal Observatory on the parallax and proper motion of Nova Persei.—Mr. H. C. Plummer partly read a paper on the images formed by a parabolic mirror.—Mr. Whittaker read a paper on periodic orbits in the restricted problem of three bodies, being an extension of the paper read at the January meeting. The problem considered was that of finding the motion of a small planet under the attraction of the sun and a large planet, the latter being supposed to move in a purely circular orbit. Two theorems were communicated in the paper, the first giving a criterion for the existence of periodic orbits and the second being concerned with the value of an integral taken over the orbit.—A note by Mr. Fourcade was read, on Prof. Turner's recent paper on photographic surveying.

Mathematical Society, March 13.—Major P. A. MacMahon, F.R.S., vice-president, and subsequently Lieut.-Col. A. Cunningham, R.E., in the chair.—The Rev. J. Cullen read a paper on the solutions of a system of linear congruences. The object of the paper is to give a graphical process for obtaining the solutions of a system of linear congruences under a given limit; and the scope of the paper consists in establishing and explaining four simple rules to be employed in applications of the process; the process yields new results in the resolution of high numbers, having factors of unknown form, into sums of squares.—Mr. G. H. Hardy communicated a paper on the theory of Cauchy's principal values. This paper is the third of a series concerned with the interpretation, and the use in analysis, of such divergent definite integrals as have in Cauchy's sense a principal value; it deals in particular with the possibility of differentiation and integration under the sign of the principal value, and gives sufficient criteria for the validity of the interchange of order of the limiting operations involved; the theory is illustrated by numerous examples of the calculation of definite integrals by processes which had not previously been proved to be valid.—Mr. R. Hargreaves read a paper on algebraic relations between zonal harmonics of different orders. The coefficients in any sequence equation connecting zonal harmonics are rational functions of the orders of the harmonics, and these functions also are connected by sequence equations; the latter equations are developed systematically.—Dr. F. S. Macaulay made a preliminary communication of some results in the theory of elimination. He showed how to express the resultant of any number of homogeneous equations in any number of variables as a quotient of two determinants.—The following paper was communicated from the chair: Mr. J. Buchanan, on quadrature formulæ. The formulæ are obtained by the use of methods of interpolation based upon central differences.

Entomological Society, March 5.—The Rev. Canon Fowler, president, in the chair.—Mr. L. B. Prout exhibited, on behalf of Mr. J. P. Mutch, *Vanessa* (*Eugonia*) *polychloros*, L., a ♀ bred by Mr. H. Baker from pupa from Stowmarket, Suffolk, the ground-colour much darkened and the black markings somewhat enlarged; *Chrysophanus phlaeas*, L., an aberration (captured in the Isle of Wight, August, 1901) much suffused with dark colour, especially at outer margin and on hindwings, only a very small patch of the red colour remaining at the inner angle of the latter; *Agrotis puta*, Hb., a perfectly halved gynandromorphous example, and *Noctua sobrina*, Gn., an aberrant specimen with white antennæ and a somewhat hoary appearance on the forewings, taken in East Aberdeenshire, August, 1900.—Mr. A. Bacot exhibited a series of *Malacosoma castrensis* and a series of *M. neustria* for comparison with a hybrid brood, resulting from a pairing between a male *neustria* and a female *castrensis*. This was the first time any exhibition of experiments of the kind had been made before the Society by British investigators, though Mr. Merrifield had shown a number of crosses bred by Herr Standfuss. The sexes, as exhibited, were very clearly distinguishable, and there was not much tendency to gynandromorphism, though of sixty or seventy specimens almost every ♀ showed some signs of ♂ coloration.—Mr. O. E. Janson exhibited a pair of *Stephanocrates dohertyi*, Jord., a Goliath beetle discovered by the late W. Doherty in the highlands of British East Africa.—Dr. T. A. Chapman exhibited cocoons of a Limacodid moth from La Plata, with empty pupa-cases of a dipterous parasite of the genus Systropus. The resemblance between the two pupa-cases is, however, not merely of appearance, but functional also. The moth-pupa, *i.e.* the moth itself inside the pupa-case, almost certainly by inflating itself with air, to secure greater size and a stiffened epiderm as a basis of muscular action, exerts an end-to-end pressure within the cocoon, and so forces off a lid. The Systropus breaks off a similar lid, no doubt by similar end-to-end pressure to that exerted by the moth, Diptera having highly developed the habit of inflating themselves with air, at emergence from the pupa. This pupa also has a beak very like that of the Limacodid, but even stronger and sharper.—Mr. J. E. Collin, in further illustration of Dr. Chapman's remarks, exhibited specimens of *Systropus*, sp. ? from Buenos Ayres, parasitic on a Bombycid Lepidopteron (*Limacodes ?*). This, he said, was possibly the same as Dr. Chapman would have reared from his cocoons. The species was apparently undescribed, but most allied to *S. brasiliensis*, Meg.—Prof. E. B. Poulton, F.R.S., read a paper entitled "Five years' observations and experiments (1897–1901) on the bionomics of South African insects, chiefly directed to the investigation of mimicry and warning colours," by Guy A. K. Marshall, with appendices containing descriptions of new species, by W. L. Distant and Colonel C. T. Bingham.—Mr. Malcolm Burr contributed a monograph of the genus *Acrida*, with notes of some allied genera and descriptions of new species —Dr. D. Sharp, F.R.S., contributed three papers by Mr. R. C. L. Perkins, respectively entitled: (*a*) Notes on Hawaiian wasps, with descriptions of new species"; (*b*) "Four new species and a new genus of parasitic Hymenoptera (Ichneumonidæ) from the Hawaiian Islands"; and (*c*) "On the generic characters of Hawaiian Crabronidæ: four new genera characterised."

Geological Society, March 12.—Sir Archibald Geikie, F.R.S., vice-president, in the chair.—The crystalline limestones of Ceylon, by Mr. Ananda K. Coomára-Swámy. The crystalline rocks of Ceylon may be divided into three series: (1) The older gneisses; (2) the crystalline limestones; (3) the granulites (charnockite series)—pyroxene-granulite, leptynite, &c. A local subdivision of this series is the Point de Galle group—wollastonite-scapolite-gneisses, &c. The crystalline limestones of Ceylon are intimately associated with the banded pyroxene- and acid granulites (charnockite series). They form bands with outcrops from a few feet to more than a quarter of a mile in width, interbedded with the granulites. The limestones themselves have a banded structure (foliation) parallel to that of the granulites and to the boundaries. Although the relation of the granulites to the limestones is on the whole intrusive, the two rocks in their present condition are essentially contemporaneous, and seem alike to have consolidated from a molten magma. The calcite occurring in the granulites near the contact has all the appearance of an original mineral. The foliation of the limestones is regarded as a sort of flow-structure, and corresponds with that of the granulites to which it is always parallel. That the foliation does not result from the action of earth-movements on a solid rock is shown by this, that the very minerals whose variable distribution is one of its chief causes have certainly not been affected by deforming earth-movements, nor are they such as to have been produced by these; moreover, in this respect a distinction cannot be made between the limestones and granulites, which would necessarily have suffered alike had they been subjected to deforming strains since the consolidation of the latter. The original nature of the limestones is less evident; they may have been sedimentary or tufaceous, and, if so, subsequently softened and metamorphosed; or possibly *ab initio* truly igneous rocks, and related to the charnockite-magma. Reasons for and against these views are given. The relations between the crystalline limestones and nepheline-syenites of Alnö have suggested to Prof. Högbom that perhaps the limestone may have been a product of the nepheline-syenite magma there. The author feels sure that the crystalline limestones of Ceylon have not arisen by the alteration of the basic lime-silicates of the pyroxene-granulites.—On Proterozoic gasteropoda which have been referred to Murchisonia and Pleurotomaria, with descriptions of new subgenera and species, by Miss

Jane Donald. Many of the Palæozoic shells referred to Murchisonia do not agree with the type, and there are at least two separate groups distinguished by the outer lip. The typical group has a slit, the other merely a sinus. From the material at present available, in the British Isles as well as in America and the Baltic provinces, elongated forms with a sinus precede those with a slit. So far, no light is thrown on the question as to whether Murchisonia and Pleurotomaria were derived from the same stock, nor has the author yet met with any specimens showing a transition from sinus to slit.

PARIS.

Academy of Sciences, March 17.—M. Bouquet de la Grye in the chair.—Some remarks on the periods of double integrals and the transformation of algebraic surfaces, by M. Emile Picard.—Studies on vegetable earth, by M. Th Schlœsing. The earth is separated by a process of levigation into fractions, which are analysed separately. The most striking fact obtained by this method of working is the rapid change in the proportions of iron and phosphoric acid in the fractions. The ratio of iron to phosphorus, however, remained practically constant.—On the culture of the fodder beet, by M. P. P. Dehérain. The method of cultivation of the beet, which aims only at producing roots of the largest size, is faulty, as analyses of such roots show that they contain an undue amount of water and nitrates. By planting out so that smaller beets are obtained, it was found that although the gross weight per hectare was somewhat less in the latter case, the weight of dry material was greater and the loss of nitrates was reduced.—M. Yermoloff was elected a correspondant in the Section of Rural Economy in the place of the late Sir J. B. Lawes.—On regular groups of finite order, by M. Léon Autonne.—On the theory of algebraic functions of finite order, by M. Beppo Levi.—On the conservation of refractive energy in mixtures of alcohol and water, by M. A. Leduc. The refractive indices of mixtures of alcohol and water can be calculated from the refractive indices of the two constituents within the limits of experimental error, allowance being made for the contraction which takes place on mixing the two liquids.—On the mobility of the ions in gases, by M. P. Langevin.—Research on a unit for measuring the force of penetration of the X-rays and for their quantity, by M. G. Contremoulins. The principle adopted for these measurements is the comparison of the intensity of illumination of a fluorescent platinocyanide screen with a screen artificially illuminated with a light of known intensity.—The heat of reaction between bodies in the solid and gaseous state, by M. Ponsot.—The heats of solution of solid and liquid ammonia taken at about $-75°$ C., and on the latent heat of fusion of solid ammonia, by M. G. Massol. The method adopted was to dissolve first liquid ammonia and then solid ammonia, both as near $-75°$ C. as possible, in water in a calorimeter; the latent heat of fusion was thus obtained as the difference between these two results. The value thus found for the latent heat of fusion for a gram-molecule of solid ammonia was -1.838, approximating to that of water, -1.43.—The volumetric estimation of thallium, by M. V. Thomas. The author has modified the iodometric method of Feit, in such a manner as to avoid the conversion into the sulphate. Test analyses are given showing the accuracy of the method as modified.—Acid and basic sulphates of neodidymium and praseodidymium, by M. Camille Matignon. Four new sulphates are indicated, their properties determined, and their thermochemical relations examined.—A method for the alkalimetric estimation of disodium-methylarsenate or arrhenal, by M. A. Astruc. The method suggested is based on the fact that in the presence of rosolic acid one molecule of this substance requires one molecule of a monobasic acid for neutralisation.—On some derivatives of arabinose, by M. G. Chavanne. The exact conditions are given for the production of a pure substance in the interaction of arabinose with acetyl chloride and bromide. The preparation and properties of the phenylhydrazone of arabinose are also described.—On the supposed binaphthalene-glycol, by M. R. Fosse. It is shown that the body described as binaphthalene-glycol is in reality dinaphthoxanthydrol, and that the derivatives of the supposed glycol are similarly constituted.—On the pseudo-acids, by M. P. Th. Muller. For a true acid the difference of the molecular refractions of the acid and its sodium salt should be equal to the difference of the molecular refractions of sodium hydrate and water, and for a large number of acids of the order of acetic this has been found to be the case, the value of this constant difference being about 1.55. Any marked variation from this value would indicate that the constitution of the acid was different from its neutral salt. This the author has found to be the case for a certain number of isonitroso-compounds of the fatty series.—On the classification of the Cercomonadines, by M. Louis Léger.—The use of organic arsenic and phosphorus compounds in the treatment of tuberculosis, by M. A. Mouneyrat. Sodium methylarsenate taken alone has no effect in preventing the excessive elimination of phosphorus in tuberculosis. But by the administration of this salt, together with an easily assimilable phosphorus compound, such as nucleinic acid, the desired result was obtained. A marked improvement was noticed in less than a month, with gain in weight, increase in appetite, disappearance of the nocturnal sweats, and of fever. At the end of a month or six weeks the sputum became normal, losing its purulent character and, in the majority of cases, with the disappearance of the tubercle bacillus.—The action of temperature on the mineral absorption in etiolated plants, by M. G. André. It was found that the quantity of ash in 100 parts of the dried material is always greater in the normal plant than in the plant etiolated at 15° C.; the reverse was the case in an etiolated plant growing at 30° C., the difference being entirely represented by silica.—On the assimilation of carbon by a green algæ, by M. P. G. Charpentier.—A bacteriological study of the *massif* of Mont Blanc, by M. Jean Binot. The number of germs in the air at the summit of Mont Blanc is extremely small, varying between four and eleven per cubic metre, and increases as the valley is approached. The ice, snow and water on the mountain were made the subject of a separate study. A virulent pyocyanic bacillus was isolated from the ice at the summit, and an exceedingly pure water taken near the Montanvert showed twelve colonies of a virulent *Bacterium coli* per cc.—Experimental researches on the mental life of a xiphopage, by MM. N. Vaschide and H. Piéron.

DIARY OF SOCIETIES.

WEDNESDAY, APRIL 2.

SOCIETY OF PUBLIC ANALYSTS, at 8.

THURSDAY, APRIL 3.

RÖNTGEN SOCIETY, at 8.30.—X-Ray Diagnosis of Renal Calculus: Dr. Ch. Leonard.

LINNEAN SOCIETY, at 8.—On the Composite Flora of Africa: W. Spencer Moore.—A Halonial Branch of *Lepidophloios fuliginosus*: Prof. F. E. Weiss.

FRIDAY, APRIL 4.

GEOLOGISTS' ASSOCIATION, at 8.—Klondike, its Geology and Mining: Prof. H. A. Miers, F.R.S.

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THURSDAY, APRIL 3, 1902.

ELASTICITY FOR ENGINEERS.

Résistance des Matériaux et Éléments de la Théorie mathématique de l'Élasticité. Par Aug. Föppl. Traduit par E. Hahn. Pp. 490. (Paris: Gauthier-Villars, 1901.) Price fr. 15.

DISCUSSIONS as to the amount of "learning of mathematics" necessary for the engineer have not been confined to this country, but have, as we learn from the preface, been keenly carried on in Germany. There appears to be a desire in some quarters to sacrifice mathematical teaching to laboratory work, on the ground of the great increase in the number of hours necessary for the latter in consequence of modern developments of electro-technics; and some writers have attempted to bring forward as an argument the rarity of the occasions on which mathematics is required by the engineer, and the large amount of time that is required to obtain a knowledge of that subject.

Prof. Föppl takes an entirely different view. While admitting that no advantage is gained by the study of purely speculative branches of mathematics, he is directly opposed to any tendency to lower the general level of mathematical knowledge of our future engineers. He lays stress on the value of mathematical training in enabling the practical man to *draw correct conclusions* on the numerous questions on which he is required to pronounce judgment, even where actual calculations are not required.

This is a view which ought to be more keenly appreciated among practical men than has been the case hitherto, and we should like to see put forward an entirely opposite suggestion to that which has apparently found favour in some circles in Germany, namely that *more* attention should be given to mathematics in the training of engineers *even* at the expense of laboratory work. It is sufficient to take up any volume of engineering transactions to find the "practical" man "plunging" into pages and pages of elaborate formulæ involving "shines and coshes," and in the end either getting no result of interest, or obtaining a simple deduction of some principle well known to every mathematician, but which the writer of the paper puts forward as if it were a new physical law. On the other hand, the engineer who has an intimate knowledge of pure and applied mathematics will know, for example, what partial differential equations are involved in the solution of any problem placed before him, and even if he knows that it is impossible to solve these for the particular type of boundary with which he has to deal, he will form a complete mental picture of the machinery underlying the system he is investigating; he will mentally classify the known and unknown quantities involved in the problem, and will see at a glance the right lines on which to determine the unknown quantities experimentally, instead of spending hours in floundering through formulæ or wasting money over superfluous experiments.

The theory of elasticity probably enters into the work of the engineer more intimately than any other branch of applied mathematics, and, at the same time, there are few subjects so difficult to present to the learner in a form that will furnish him with a definite mental picture of the phenomena concerned. So far as we are aware, no one has, as yet, ever attempted to construct diagrams of the deflections of a rectangular sheet of steel plating by dotting it over with microscopists' cover-glasses, silvered on the back, allowing these to reflect light from a source on to a screen and observing or photographing the displacements of the bright spots when one side of the plate is submitted to pressure or a weight is applied at any point of its surface; yet this would not be difficult to do, and would certainly give interesting results.

The present work is the French translation of a book written by Prof. Föppl expressly for the purpose of giving engineers an insight into the mathematical theory of elasticity. It commences with a chapter on the analysis of stresses, which we regret to see entitled "Forces intérieures ou actions moléculaires." When will writers adopt some consistency in their use of the words *molecule* and *molecular?* In text-books on hydrodynamics, the term *molecular rotation* is often found applied to a quantity which by no means represents the rotation of the actual molecules of the fluid, but is merely the curl of the velocity. Thus it follows that the "molecular rotation" of Basset and other text-book writers vanishes when a fluid is moving irrotationally, while the kinetic theory of gases tells us that in a mass of gas *at rest* the molecules are in rapid rotation, the kinetic energy of the true molecular rotation bearing a determinate ratio to that of molecular translation, except probably in the case of a monatomic gas. Similarly M. Föppl takes no account of the molecular structure of the body, there is no reference to Boscovich's or any other hypothesis, and his "molecular" actions, so-called, are nothing more or less than the ordinary stresses in the element $dx\ dy\ dz$. Seeing that $dx\ dy\ dz$ is called an element, why not consistently use the term "elemental" or "elementary" for such actions? In the next chapter, which deals with analysis of *strain* as opposed to stress, this is done, the nomenclature "déformations élémentaires" being adopted. This chapter contains discussions on the elastic limits, Woehler's experiments and diagrams of the relations between stress and strain beyond the limits of Hooke's law. The third chapter is devoted to flexure of beams, and it includes digressions on moments of inertia and the method of finding them with a planimeter. Of graphical interest is the diagram showing the enveloping curves of the lines of stress (p. 120). The next chapter deals with the potential energy of deformation, and includes Castigliano's interesting theorems and Maxwell's reciprocal property.

Chapter v. deals with curved beams or prisms, and the next chapter with the problem (prisms resting on a compressible base) presented by the yielding of railway metals under the weight of a train. This is followed by a chapter on the plane plate, after which come thin and thick shells. The ninth chapter deals with the torsion problem. The solution for a rectangular beam is, however, wrong. The author finds stress components represented by algebraic expressions of the third degree, and shows that these satisfy the stress-equations, but he omits to show that these expressions are compatible with the strain-equations—professedly in order to obtain

as simple a result as possible, even if approximate, but really because his is not the correct solution of a problem, that obtained by Saint Venant's method involving series of transcendental functions. We miss the well-known equilateral triangle and the algebraic solutions representing sections approximately square. Chapter x. deals with the collapse (*flambement*) of beams under end thrust or torsion.

"The elements of the mathematical theory of elasticity" is the title of the last chapter. In it the differential equations of elasticity are expressed in terms of the displacements, and the applications include wave-propagation, Saint Venant's torsion problem (still without reference to the rectangle or equilateral triangle), Boussinesq's and Hertz's theorems.

A special feature of the book is the collection of examples at the end of each chapter. These, of which the solutions are given, are, as examples should be, mostly straightforward applications, frequently numerical, of the bookwork, and though some of them are necessarily rather long, none of them are without some practical interest. It is very likely that many a mathematician brought up on tripos riders might find the numerical calculations puzzling at first, but is it not essential to understanding a theory properly that it should be tested by numerical examples and not merely by "neat analytical results"? Another feature is the synopsis of formulæ at the end of the book.

This is not exactly the book which a mathematician would use to learn elasticity from by preference, but then it was not written for mathematicians. In endeavouring to present the theory of elasticity in the most practical aspect possible so as to bring it within the range of engineering students, the author appears to have achieved his object with remarkable success, or in the conventional words of the reviewer, "this book is admirably adapted to the requirements of the class of readers for whom it is specially written."

DETERMINATIVE BACTERIOLOGY.

A Manual of Determinative Bacteriology. By Frederick D. Chester. Pp. vi + 401. (New York: The Macmillan Company, 1901; London: Macmillan and Co., Ltd.) Price 10s. 6d. net.

ALL branches of science in the early stages of their development suffer from the want of a uniform nomenclature. But it is in the biological sciences, especially zoology and botany, that the greatest confusion has prevailed, more particularly in the naming of the multitudinous forms of animal and plant life. Thanks, however, to the codes of rules drawn up at various conferences, and more or less universally accepted, the systematic nomenclature of zoology and botany has become much more uniform and simple, while these branches both possess a recognised terminology for descriptive purposes.

It is otherwise with bacteriology. This science, though primarily a branch of botany, has been mainly developed by those who could not claim to be trained botanists, and the bacteria have been studied and classified with little reference to the relations existing among themselves and to allied forms; hence the nomenclature, both systematic and escriptive, is in a chaotic state. Moreover, descriptions of new forms are continually appearing in a number of journals, so that it is extremely difficult without an enormous expenditure of time to discover whether a form has previously been described or no, as hitherto there has been no catalogue of species available. It is with a view to purge bacteriology of some of these reproaches that the present work has been compiled. The author modestly states in the preface that he "does not claim that the system of arrangement is perfect. . . . The present tables serve, therefore, only for purposes of identification and not necessarily for those of classification." The opening chapter is devoted to an account of the morphology and biology of the bacteria; in the second a genuine attempt is made to devise a system of terminology for descriptive purposes. The various forms of growths, of colonies, &c., receive appropriate names, so that what was formerly a long description may be condensed into a few words. For instance, the gelatin stab culture of anthrax is "an arborescent growth becoming a crateriform to saccate liquefaction," and the agar colonies of the same organism are simply "floccose." The preparation of standard nutrient media is then described, a reaction of + 0·5 being preferred to that of + 1·5 adopted by the Committee of the American Public Health Association. Some staining methods are next briefly mentioned, and a few pages are devoted to a study of the chemical functions of bacteria, a table of chemical separations, and a scheme for the study of bacteria.

In chapter iii. the classification of the bacteria is dealt with, that adopted being on the basis of the one described by Migula in his "System der Bakterien," and the various species are tabulated at length and upon a definite scheme. This portion of the book occupies more than 300 pages and must have entailed considerable labour in its compilation. The cultural and other characters of each organism are described upon a consistent plan, while the various species are divided up into small groups by certain prominent characteristics, such as chromogenic, liquefying, Gram-staining and other properties. By this subdivision, and the synopsis of characters given before each group, it is possible, as the author points out, to place a culture in the hands of a student and for him to determine the species. Those who are acquainted with the older works of Eisenberg, Lustig, &c., will accord a hearty welcome to these tables. The classification, as stated before, is that of Migula, but the nomenclature of species has been made to accord with the rules of botanical nomenclature, with a rigid insistence upon binomial names and upon the rule of priority. At the same time, the synonymy of, and earliest reference to, each species is given. This is no doubt a great advance, though perhaps inconvenient at first, as it involves the renaming of a number of familiar species, sometimes with far less appropriate names than they have at present. For example, the bacillus of mouse septicæmia was conveniently termed the *Bacillus murisepticus* by Flügge in 1886, but a year previously Trevisan had named it the *Bacterium insidiosum*, and therefore "*insidiosus*," by the rule of priority, must stand as the specific name. Curiously enough, having discussed this very organism as an example of the rule of priority at length at p. 48, when it comes to the actual description of it (p. 353) the author tabulates it as *Mycobacterium murisepticum* in-

stead of "*insidiosum*," as, from his own showing, it should be. Similarly, the bacillus of hog cholera, the *B. suipestifer*, Kruse, becomes the *B. Salmoni*; the organism of chicken cholera the *B. cholerae*; Koch's comma bacillus of cholera *Microspira comma*, &c.

In a work which as a whole is so excellent, it would be invidious to criticise minor points, and the following remarks should therefore be regarded as suggestions for amendment in a future edition.

The description of the *Bacillus enteritidis*, Gärtner, is too brief, and this organism does not ferment lactose. All peritrichic forms are indicated by a "B" in heavy type. Those which are presumably so, but about which there is no definite information, are designated by a "B" in lighter type; the distinction between the two letters should be made more marked. The *B. Welchii* and *B. emphysematosum* (p. 183) are, according to Welch, identical. In places the terminology needs revision, *e.g.* *M. eczemae* (p. 86) and *M. epidermis* (p. 62). The reviewer has searched in vain for any mention of the *Micrococcus melitensis*.

While the index is a very full one, it might be yet more complete with advantage—for example, in all cases both the ordinary name and the one adopted should be given, but this is not done. Anyone searching for the *M. agilis* would not find it unless he knew that the organism was flagellated and belonged to the genus Planococcus. There is no reason why "Bacterium" should be indexed before "Bacillus." The *B. aërogenes capsulatus* is wrongly indexed (p. 269, instead of p. 183). The work concludes with a glossary of terms and a short bibliography. As regards the latter, one reference reads "Trevisan-de-Toni, &c."; it should be "Trevisan *and* de Toni in, &c." Moreover, another work by Trevisan, "Gen. e spec. delle Batteriaceæ" (1889), although frequently alluded to in the text, is not mentioned in the bibliography.

R. T. HEWLETT.

STRATIGRAPHICAL GEOLOGY.

The Student's Handbook of Stratigraphical Geology. By A. J. Jukes-Browne, B.A., F.G.S. Pp. xii + 589. (London: Edward Stanford, 1902.) Price 12*s*. net.

AS stated in the author's preface, "this volume is based upon the 'Student's Handbook of Historical Geology' published by Messrs. G. Bell and Sons, and may be regarded as a second edition of that book." It has been entirely rewritten, however, and brought up to date; moreover, the alterations and additions are so numerous and important that to describe it without qualification merely as a second edition of that work is, we think, to give a wrong impression of its increased merits.

The former book, which was published in 1886, was in most respects an excellent work and contained a surprising amount of information; but, in our opinion, it had a serious defect. It was somewhat lacking in interest, dry, and not very readable. Fortunately for the student, this fault, which it is very difficult, often impossible, to avoid when, as in this case, the information to be imparted consists in the main of the statement of a host of details, has in the present volume been largely remedied; and the author is to be congratulated upon the manner in which, while greatly augmenting the number of recorded facts, he has succeeded in maintaining the general interest of his subject.

Of the eighteen chapters which comprise the text of the volume, the first four deal with the principles involved in the science of stratigraphy. They follow the same general plan as was previously adopted. The fifth, however, is quite an innovation. It gives information to the student as to the principal works on general stratigraphy which are available in this country, and as to the facilities which exist for ascertaining what has been published, in the way of maps and special treatises, concerning the stratigraphical geology of any district in the British Isles of which he may wish to acquire a deeper knowledge. It should prove especially useful to students who are self-taught.

The remaining chapters are devoted to the study of the several geological systems, which are taken, as before, in the ascending order. The nomenclature adopted for the systems is simple and satisfactory. The substitution of the terms Palæogene and Neogene, originally suggested by Hœrnes for the Tertiary systems and now widely employed on the continent, in place of the terms Hantonian and Icenian used in the first edition, is, we think, an improvement in terminology. The chapters dealing with the Palæozoic systems have been very considerably expanded, with the result that these systems now receive a fairer share of attention than was the case in the first edition.

The author has adopted a capital plan of placing the literature-references at the end of each chapter, where, with the addition of such others as are necessary to make the list tolerably complete, they constitute a most useful bibliographical index of the subject dealt with in the chapter.

The main bulk of the book treats of British stratigraphy. Such accounts as are given of foreign rock-groups are comparatively short, and, except in a few special cases, are confined to those of the European continent. This, to some extent, limits the use and value of the book; but to us it seems that the author has done well to make his description of foreign strata quite subordinate to that of beds at home which every student has the opportunity of seeing and examining in the field for himself. In order to have included a satisfactory treatment both of British and foreign stratigraphy it would have been necessary to increase the size of the volume to such an extent that its cost would be prohibitive to most of those for whom it is especially written.

One of the greatest improvements in the book in its new form is the addition of a number of sketch-maps illustrating the geology of many of the more specially interesting districts in England and Wales. These, which are in part derived from previous publications and in part have been prepared for the work, from the maps of the Geological Survey, are clearly and effectively drawn, and greatly facilitate a ready comprehension of the text. The author's suggestion that the student should tint them with suitable washes of colour is a good one; the exercise intelligently carried out, besides enhancing the value of the diagrams, should also serve to impress the geology of each district more permanently upon his mind.

The number of explanatory geological sections has been considerably increased, and the same is true of the figures of fossils. The volume is, indeed, admirably illustrated. It is an important and welcome addition to the list of English treatises which are especially designed for the use of the student of stratigraphical geology, and one which we can most confidently recommend, not only to students, but to all who desire a trustworthy representation of the present state of our knowledge of British stratigraphy.

OUR BOOK SHELF.

Birds' Nests, an Introduction to the Science of Caliology By Charles Dixon. Pp. xiv + 285; i illustrated (London: G. Richards.) Price 6*s.* net.

IF we may judge from a statement on p. 7, Mr. Dixon is of opinion that stone-throwing is a proper and suitable practice for the tenants of glass houses. For since he classes Darwin as a "compiler," he can scarcely have the presumption to exclude himself from the same category! As a matter of fact, Mr. Dixon's works are to a great extent compilations from the writings or observations of others, and the present volume appears to be no exception to the rule.

That popular works of the class of those for which Mr. Dixon is responsible must almost necessarily contain a large percentage of copied matter we are fully prepared to admit, but when the author of such works sees fit to refer in contemptuous terms to one of the master minds of the last century he must not be surprised if critics treat his own productions and methods with scant courtesy.

In the volume before us, Mr. Dixon claims to have opened up a practically new branch of ornithology, which he designates, very unnecessarily, as "caliology." He further states that no work has been entirely devoted to this subject for the last seventy years. In this it may be taken for granted that he is correct, although it would be a mistake to suppose that other writers have not devoted a considerable amount of attention to the subject. Indeed this is evident from the work itself, in which the author quotes the views of Dr. A. R. Wallace, Dr. E. Goeldi and other eminent zoologists. Mr. Dixon has the knack of putting what he has to tell in an agreeable and attractive manner before the public, and had he not gone out of his way to cast a slur on the reputation of a great man we should have been more inclined to bestow a modicum of praise on his efforts than we feel justified in doing as matters now stand.

The plan of the work is to describe the nest-building of birds in a progressive manner, commencing with those species the nests of which are of the simplest type (or rather with those which make no nests at all), and gradually passing on to those, such as the tailor-birds and hang-nests, which construct nurseries of the most elaborate type. Mr. Dixon is one of those who believe that the nest-building instinct is not inherited and that birds learn to build by practice and instruction. He considers this belief to be strengthened by the case of a nest (which he figures) built by a pair of chaffinches taken to New Zealand before their first nesting season. The nest built by them in the antipodes is of a very abnormal type; but is it certain that this may not be accounted for by difference of environment and material? Another plate, in which the bird is depicted in a very remarkable posture, shows the eggs of a greenshank in the deserted nest of a fieldfare. We may say in conclusion that those who have never previously studied birds' nests with attention will find much to interest them in Mr. Dixon's latest volume.

R. L.

Lancashire Sea-Fisheries Memoir. No. 2, *Fish and Fisheries of the Irish Sea.* By W. A. Herdman, D.Sc., F.R.S., and Robert A. Dawson. Pp. 98. (Liverpool: Philip.) Price 5*s.* net.

IN the second of the Lancashire Sea-Fisheries Memoirs, Prof. Herdman and Mr. Dawson summarise, for the use more especially of the members of the Lancashire and Western Sea-Fisheries District Committee to whom the volume is dedicated, the more important results bearing upon practical fishery questions which have been obtained from the scientific researches carried on during recent years in the Irish Sea. The information given is for the most part not new to the scientific student, as it has already been made known through the various reports of the Liverpool Biological Society.

The work commences with a useful account by Prof. Herdman of the physical and biological conditions which are found in the Irish Sea, more especially in that part of it which lies between the Isle of Man and the Lancashire Coast. This account includes some interesting information, supplied by Mr. Clement Reid, on the geological features of the bottom deposits obtained from different parts of the area under consideration.

After a brief description of the invertebrate fauna, a complete list of the fishes of the district is given, with details of the geographical and local distribution of each species. It is to be regretted that more information as to the habits and life-histories of the various fishes is not supplied in this portion of the work, as such information would have rendered it both more interesting and more useful to those for whom it is intended.

The memoir concludes with a chapter by Mr. Dawson on the constitution and work of the Lancashire and Western Sea-Fisheries Committee and two appendices, one containing the bye-laws of the Committee and the other some detailed results of various experimental hauls of the trawl.

Plant Structures. By John M. Coulter, A.M., Ph.D. Pp. vii + 348. (London: Hirschfeld Brothers, Ltd., 1901.) Price 6*s.* net.

FORMER books by the professor of botany in the University of Chicago have been characterised by a concise and rational elucidation of the subjects treated, and this applies also to the book under discussion. In "Plant Relations," a first book on botany, Prof. Coulter dealt mainly with ecological factors. "Plant Structures" gives a brief outline of the various great groups of the plant kingdom. The life-histories of common or important types are used to illustrate the gradual transition from the lowest algal plants to the complex, highly modified group of spermaphyta, and also to introduce the student to the widely varying structures and methods of reproduction which obtain among plants. The types chosen are, for the most part, similar to those found in other elementary text-books; a new ascomycetous type is furnished by *Microsphaera*, a mildew which occurs on lilac leaves. In addition, many other interesting examples are quoted and, to a great extent, illustrated; in fact, there is an almost superabundant wealth of illustration.

It cannot be said that the author has struck any original vein, but the strength of the book lies in clear and sound representation of facts, and in logical sequence of argument; also, where it is appropriate, the result of recent work has been embodied, as, for instance, the occurrence of sperms in the Cycads, and chalazogamic fertilisation in the Dicotyledons, for which original illustrations are given. The author is especially happy in his treatment of the Angiosperms as he traces the various evolutionary series of floral modifications. There are two points in which there will not be general agreement with the author; the term "spore" is not confined to sexual reproduction, but the result of fusion of ovum and sperm is also defined as a spore; again, how can the spelling of *Edogonium* be made to accord with its derivation?

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

Magic Squares of the Fifth Order.

IN the interesting discourse reproduced in your issue of March 13 (p. 447), there is a statement that the number of magic squares of order 5 exceeds 60,000. Major MacMahon informs me that he gave these figures on the authority of Rouse Ball's "Mathematical Recreations." The statement is not wrong, but viewed as a minimum limit it may be largely exceeded. I have recently investigated the total number of squares of this order, which have the additional property that the nine numbers in the heart of the square also form a magic—the well-known "bordered squares." Fig. 1 is an example. The square itself is magic in rows, columns and diagonals, and the nine numbers in the central square show like properties.

It is easy to see (1) that the numbers in the central square must consist of three arithmetical progressions with a like common difference; (2) that the first terms of each progression must also be in arithmetical progression; and (3) that the mean number (13) must always occupy the central cell. Hence it follows that (excluding the central number) the eight numbers in the heart must consist of four pairs of complementary numbers (*i.e.*, pairs whose sum is 26, or twice the mean), and also that the two smallest numbers being known, then all the others are known. If, for example, the two lowest numbers in the heart are a, $a+k$, then the nine numbers in the centre, taken in numerical order, must be a, $a+k$, $a+2k$; $13-k$, 13, $13+k$; $26-2k-a$, $26-k-a$, $26-a$. It is now easy to determine in how many ways we may choose the nine numbers for

2	25	23	10	5
14	11	22	6	12
19	8	13	18	7
9	20	4	15	17
21	1	3	16	24

FIG. 1.

5	25	24	4	7
11	10	23	6	15
12	9	13	17	14
18	20	3	16	8
19	1	2	22	21

FIG. 2.

the centre on the usual assumption that we are restricted to the first 25 natural numbers without repetition or omission. The total is 26, as shown in the first column of the table below, where the figures in brackets denote the two lowest numbers in the heart.

Type.	Number of subtypes.	Type.	Number of subtypes.
A. (1, 2) ...	... 28	N. (4, 5) ...	... 30
B. (1, 3) ...	... 31	O. (4, 6) ...	... 23
C. (1, 4) ...	... 18	P. (4, 8) ...	... 30
D. (1, 6) ...	... 21	Q. (5, 6) ...	... 16
E. (2, 3) ...	... 30	R. (5, 7) ...	... 20
F. (2, 4) ...	... 30	S. (5, 8) ...	... 20
G. (2, 5) ...	... 26	T. (6, 7) ...	... 19
H. (2, 6) ...	... 29	U. (6, 8) ...	... 18
I. (2, 7) ...	.. 23	V. (6, 9) ...	... 28
J. (3, 4) ...	... 23	W. (7, 8) ...	... 19
K. (3, 5) ...	... 23	X. (8, 9) ...	... 29
L. (3, 6) ...	... 13	Y. (8, 10) ...	... 18
M. (3, 7) ...	... 27	Z. (9, 10) ...	... 10
TOTAL ...		...	... 602

These we may call the 26 main types of bordered squares of the fifth order. The 16 remaining numbers have evidently to be arranged in the four borders in such a way that complementary pairs are opposed at the opposite ends of rows, columns, or diagonals, with the additional condition that the four borders must each sum 65. Now when we deal a pair of complementary numbers into the top and bottom rows, we clearly give to those rows a difference equal to the difference of the complementary pair. If we call this a "complementary difference," then the numbers in the two rows must be so related that the sum of two complementary differences must equal the sum of the other three, and a similar relation must hold between the two lateral borders. Suppose we are dealing with type L. (3, 6). The numbers for the centre are 3, 6, 9; 10, 13, 16; 17, 20, 23. If now we arrange the remaining numbers in two columns, with complementaries adjacent, and form a third column of half differences, we have:—

		Half Difference.
1	25	12
2	24	11
4	22	9
5	21	8
7	19	6
8	18	5
11	15	2
12	14	1

It is then necessary to form two equations from the column of half-differences of the form $a+b=c+d+e$, and so related that two and only two numbers shall be common to both equations, and that these two shall be on opposite sides of the equality sign in one equation, and on the same side in the other. In the case of type L. we can do this in thirteen different ways, as shown below, the italicised figures denoting the corner pairs:—

$$\left.\begin{aligned}12+11&=9+\mathit{8}+\mathit{6}\\ \mathit{6}+5&=\mathit{8}+2+1\end{aligned}\right\}a. \qquad \left.\begin{aligned}12+\mathit{8}&=9+\mathit{6}+5\\ \mathit{8}+\mathit{6}&=11+2+1\end{aligned}\right\}b.$$

$$\left.\begin{aligned}12+\mathit{6}&=9+\mathit{8}+1\\ 11+5&=\mathit{8}+\mathit{6}+2\end{aligned}\right\}c. \qquad \left.\begin{aligned}12+6&=\mathit{9}+8+\mathit{1}\\ \mathit{9}+5&=11+2+\mathit{1}\end{aligned}\right\}d.$$

$$\left.\begin{aligned}\mathit{12}+5&=9+6+2\\ 11+8&=\mathit{12}+\mathit{6}+1\end{aligned}\right\}e. \qquad \left.\begin{aligned}12+5&=9+\mathit{6}+\mathit{2}\\ 8+\mathit{6}&=11+\mathit{2}+1\end{aligned}\right\}f.$$

$$\left.\begin{aligned}12+2&=8+\mathit{5}+\mathit{1}\\ 11+\mathit{5}&=9+6+\mathit{1}\end{aligned}\right\}g. \qquad \left.\begin{aligned}12+\mathit{1}&=6+\mathit{5}+2\\ 9+8&=11+\mathit{5}+\mathit{1}\end{aligned}\right\}h.$$

$$\left.\begin{aligned}\mathit{11}+\mathit{9}&=12+6+2\\ \mathit{9}+8&=\mathit{11}+5+1\end{aligned}\right\}i. \qquad \left.\begin{aligned}11+9&=12+\mathit{6}+\mathit{2}\\ \mathit{6}+5&=8+\mathit{2}+1\end{aligned}\right\}j.$$

$$\left.\begin{aligned}\mathit{11}+8&=12+6+\mathit{1}\\ 9+5&=\mathit{11}+2+\mathit{1}\end{aligned}\right\}k. \qquad \left.\begin{aligned}\mathit{11}+8&=12+\mathit{5}+2\\ \mathit{11}+\mathit{5}&=9+6+1\end{aligned}\right\}l.$$

$$\left.\begin{aligned}11+5&=8+\mathit{6}+\mathit{2}\\ 9+\mathit{6}&=12+\mathit{2}+1\end{aligned}\right\}m.$$

Each of these 13 pairs yield a subtype under type L. For example, take the first pair. The first equation tells us that the greater of the two pairs of numbers whose half-differences are 12 and 11 can be associated in one border with the lesser of the three pairs whose half-differences are 9, 8 and 6, the complements, of course, being opposed in the opposite border. The other equation gives similar information regarding the other two opposed borders. The centre can be arranged at once by following the order of the ordinary magic of the third degree. The result is shown in Fig. 2.

The table above gives the number of subtypes for each main type, the total being 602. The result has been verified by another worker independently.

It is now easy to calculate how many bordered magics of the fifth order exist. The centre for a given subtype we know can be arranged in one way only if reversions and reflections are *not* reckoned as different; in eight ways if they are so reckoned. Consider the top row in any one of the 602 subtypes. For the left-hand corner we have four choices, for the next cell six, and for the third cell two. This leaves three choices for the second cell of the left-hand border and two for the third. The numbers in all the remaining border cells are now known. There are, therefore, $4\times 6\times 2\times 3\times 2=288$ ways of arranging the borders for each sub-type. The total number of squares is thus $602\times 288\times 8$ if reversions and reflections are reckoned as different; $602\times 288=173,376$ if they are not so reckoned.

When we bear in mind that this is the number of magics of a restricted type, it is clear that the number of magics of the fifth order must largely exceed this total; indeed, everything suggests that the totality of magics of the fifth order is more than twice as great as the above result.

C. PLANCK.

Haywards Heath, March 15.

Rotation of a Lamina Falling in Air.

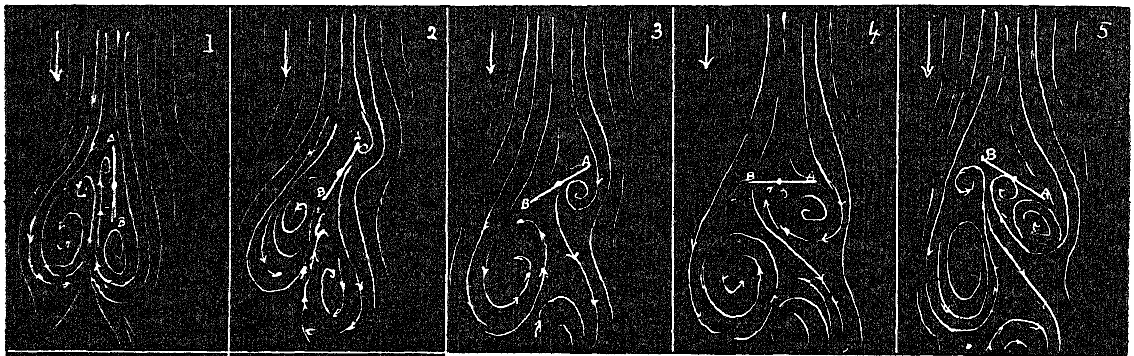
IN your issue of March 20, Dr. Johnstone Stoney, in reference to the behaviour of ice spiculæ in the clouds, instances the spinning of a card when dropped through the air.

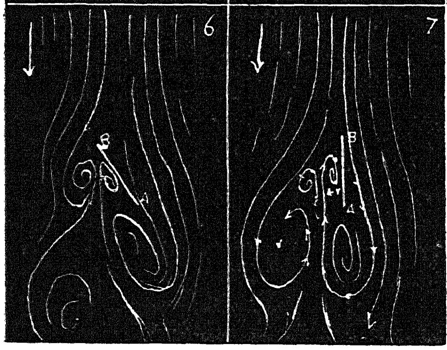
I think Lord Rayleigh was the first person to point out how curious this phenomenon is and to show that the axis of a spinning lamina might be held between bearings without affecting the result. Also that a lamina so held and placed in a draught was equally ready to spin in either direction, thus precluding the idea that the rotation might be due to some want of symmetry in the lamina itself.

A few years ago I made some experiments on the rotation of laminæ in air currents.

The laminæ were mounted in bearings as frictionless as I could make them, and the experiment consisted (*a*) in measuring the speed of the air and the angular rotation of the lamina, (*b*) in mapping the flow of the air past the lamina. This was done by the use of smoke and intermittent illumination.

It would take too long to describe the apparatus in detail, but some of the results may be of sufficient interest for publication.





Sketches of the position ot the eddiesf ormed in the neighbourhood of a rotating lamina, A B.

Thus, the angular velocity of the lamina was found to be (through a considerable range of air speed, v, and breadth of lamina, b) = constant $\times \frac{v}{b}$.

There is a limit, however, to the smallness of the lamina which will revolve (*e.g.* small laminæ of gold-leaf a tenth of an inch long and two or three hundredths broad do not revolve, but oscillate as they fall).

The cause of the rotation depends on the way in which the eddies are formed on the downstream side of the lamina.

The changes which occur, in the eddy making, during half a revolution are shown in the accompanying sketches.

From these it will be seen that the spin causes the air to flow unsymmetrically with regard to the axis of the lamina, and that there will be, on the whole, a transverse force on the axis tending to press it in the direction of rotation of the leading edge.

It can be seen also that *before* the lamina reaches the positions 1 or 7, there will be a couple acting on it tending to accelerate the rotation, and that the couple will certainly be positive from position 1 to 3. It may be negative from between positions 3 and 4 to 6; but at any rate for more than half the total time the rotation is being accelerated.

To calculate the magnitude of the couple *a priori* is, I believe, beyond the power of mathematical analysis at present.

The experiments just alluded to were made with light rectangular laminæ, but these conditions are not essential—pennies spin very nicely when dropped from a great height.

I have not succeeded in making a lamina spin in a current of water, probably because the densities of the fluid and solid are not sufficiently different, but if a flywheel were fixed on the axis of the lamina, so as to be out of the water, and thus increase the moment of inertia of the turning body without altering the fluid friction, &c., rotation might perhaps be obtained in this case also.

A. MALLOCK.

March 22.

Mathematics and Science at Cambridge.

To those who have at heart the advancement of scientific knowledge in Great Britain it is impossible but to acknowledge that the country owes a profound debt of gratitude to the University of Cambridge. During the dark ages of education her colleges formed the stronghold of modern culture; and the principle was there maintained that to the students of dead languages, however paramount they might be without her walls, within them no more than equal rights should be conceded. This involved a contest in which the principals were the mathematicians and classics, and the terms of peace a system of specialisation coupled with a certain test examination, an inquisitorial farce known as the Little-Go. This system, adopted doubtless in order to obviate the difficulty of forming a combined curriculum of studies which appealed to totally dissimilar tastes, has since been so widely extended in its application as to divorce subjects which are germane in character and naturally adapted for a close alliance. The climax is reached in the ever-growing barrier which separates mathematics from natural science, and which is year by year made more impassable by the examinations for entrance scholarships. These are of high value; and without this aid from the funds which the college authorities hold in trust for educational purposes many a brilliant man would be unable to consummate his work at school by a university career. It is, therefore, necessary that school curricula should be arranged in strict accordance with their requirements.

In view of their future careers, schoolboy mathematicians are divisible roughly into three classes—those who will make a profession of mathematics, those who will apply mathematics to science, and those who will, after obtaining academic honours, entirely sever their connection with the subject. To the last of these the question of syllabus is of comparatively small importance. But to the first and second it is of the utmost importance, and especially to the second, as it is essential to a man who for several years studies mathematics with an ulterior object in view that, while he should acquire a thorough grasp of the principles of the subject, he should not be forced by examining bodies to apply himself to what can only be regarded as intellectual pastimes; nor even in the case of the first can great skill in work of this class rank *pari passu* with a grasp of principle.

Consider the case of an able schoolboy who makes mathematics his chief study between the ages, say, of fifteen and nineteen; this period should suffice to give him a working knowledge of three-dimensional analysis, integral calculus and differential equations with their applications to the mechanics of solids, in addition to the subjects now required by the colleges, were it not for certain side issues which have arisen from the latter and assumed stupendous proportions. Foremost among these stands the excessive measure of attention given to the analysis of curves of the second degree. These form naturally a small section in a treatise on analytical geometry; yet while the far-reaching principles of the latter are lightly passed over, there is scarcely a method so abstruse or an artifice so petty that it may not give rise to a question in an entrance scholarship paper if its bearing be upon conic sections; so that no less than a third of a schoolboy's mathematical hours are frequently sacrificed to these curves. Their real interest is due, firstly, to their appearance in astronomy (the properties there required are few, and might be treated in the appendix of a text-book on dynamics), and, secondly, to their adaptability to treatment by pure geometry, the direct methods of which lend them an interest which is alien to every other branch of mathematics, and supply a mental discipline which is elsewhere unattainable. On this alone rests their title to rank as a separate subject.

But this, though the most aggravated, is not the only instance of the kind. The time spent on advanced trigonometry is out of all proportion to its practical or educational value; the subject contains an introduction to the use of the complex quantity which properly forms part of the theory of functions, and includes a number of highly specialised problems which have no place in a syllabus so elementary as to exclude the integral calculus. A similar waste is caused by several large classes of questions, especially some on series, the ability to solve which implies nothing but an effort of memory, and by other fragments of high subjects which are thrust upon boys at an early stage and made artificially difficult by isolation from their proper context.

The above criticisms are not made in any spirit of hostility to examiners, who in framing their papers are trying to obviate the shortcomings of a system which is out of date and in need of radical reform. Five decades ago it was doubtless advisable, in view of the then state of school mathematics, to limit the entrance scholarship course to a few subjects, but under new and improved conditions is not an extension of syllabus preferable to the interweaving with these of a quantity of matter which, valuable as it may be to the problem setter, is for the student little else than a barrier to his progress?

But if the examinations in mathematics and science are to be brought into harmony, it is not only in the former that a new regime is needed. Under present conditions a boy could learn at school nearly the whole of the mathematics necessary for an advanced physical course. But to do this would jeopardise his chance of obtaining a first class in the science tripos unless the authorities recognised the value of his mathematical training by a substantial equivalent of marks, so that he might make a mathematical entrance scholarship the preliminary to a science course. For those who have not a taste for theory it would still be possible to adopt an experimental regime from the outset, though it is questionable whether they could in the long run bear comparison with men who had cultivated a faculty which it is no exaggeration to call a sixth sense. The glory of Cambridge and her highest traditions are centred in the names of her mathematical physicists. But the environment which surrounded Maxwell and Kelvin no longer exists. And to-day the growth of subjects and the consequent tendency to specialisation have gone far to materialise the phantom barrier which separates the practical from the theoretical, and have laid on the authorities the burden of creating a new system which shall be capable of reproducing the giants of the past.

Dulwich College, March 13. C. A. RUMSEY.

The Morphology of Pleuronectidæ.

IN the *Memoir* on the Plaice by Messrs. Cole and Johnstone, reviewed in NATURE of March 20 (p. 459), there is a reference to Steenstrup's work on the metamorphosis of Pleuronectidæ which I think the reviewer would have done well to correct. The statement to which I refer is the following:—"This supposition (that the left eye passed through the substance of the head to reach the ocular side), absurd as it may seem to us now, was in fact believed by such an observer as Steenstrup." The truth of the matter is that Steenstrup did not believe any supposition, absurd or otherwise, on the subject, but stated from actual observation that in certain larval Pleuronectidæ the eye of one side passed through the tissues of the head and emerged on the other side. The form in question was long known as Plagusia, and is now known to be the larva of Rhamboidichthys. The truth of Steenstrup's observations was fully confirmed by Alexander Agassiz at Newport, R.I.

On the other hand, in the "Story of Life in the Seas," by Prof. S. J. Hickson, it is stated that in the young of the soles the eye of one side passes through the head to the other side. This is equally incorrect.

Messrs. Cole and Johnstone also state that the Gadidæ are the nearest relatives of the Pleuronectidæ, and promise to show that the morphological differences between the cod and the plaice, apart from the question of symmetry, are comparatively few and unimportant. I cannot find in the *Memoir* that they have redeemed this promise, and the morphological similarity of the two forms is contradicted by the authors themselves on p. 185 of the *Memoir*. I believe it could be shown by proper investigation that the morphological differences between these two fish are numerous and profound.

I think some explanation was due from the reviewer concerning Dr. Woodward's "startling discovery" that in Cretaceous times Teleostei of the Clupeoid type had already translocated the pelvic fin into the jugular position. I have not yet had the pleasure of seeing Dr. Woodward's latest volume, but a Clupeoid with jugular fins seems to me indeed a startling discovery.

Penzance, March 22. J. T. CUNNINGHAM.

WHEN writing I was well aware that the sentence Mr. Cunningham quotes was not happily construed, but seeing that comment (like that of Mr. Cunningham himself) would needs be hypercritical, I allowed the matter to pass, in consideration of the context and of the desire to keep my review within bounds.

Concerning the Cretaceous teleostean described by Dr. Smith Woodward, I can only express my surprise that Mr. Cunningham should be so neglectful of the current literature of his subjects as to be unaware of its occurrence. With the rest of his letter I have no concern.

THE WRITER OF THE REVIEW.

Sun Pillars.

I HAVE been deeply interested in the correspondence in NATURE bearing on the appearance of sun pillars, and particularly so in the communication of Prof. Johnstone Stoney (p. 465).

The display of March 6 mentioned by the Rev. Guy Bridges and Mr. W. A. Knight was not visible here; but a very noteworthy occurrence of the phenomenon took place here on December 3 last and another on January 7 last, and there was one feature common to both of these events which has not been mentioned as occurring in relation to those recorded by other observers, so far as I am aware, but which seems to me to be a prime factor in the causation of the phenomenon under consideration, and it is this:—Before, and after, the actual time of the setting of the sun, during my own observations, there was a strong display of cirrus cloud in the "true cirrus" form of parallel bars, which appeared to run at right angles to the track of the setting sun, and roughly parallel, of course, to the horizon. As the setting sun neared the horizon, these bands of cloud became magnificently iridescent, displaying the spectrum colours of the rainbow, with the red nearest the horizon. As the sun set further the colours faded, beginning first at the red and following on in succession to the violet until this colour alone remained visible. Then ascended a beautiful pillar of a violet colour in exquisite shades, ascending gradually to a height of somewhere about twenty degrees above the horizon and then fading away slowly.

It seemed to me that the occurrence depended on (*a*) the presence of cirrus cloud (ice spiculæ); (*b*) these clouds must be in a banded or striated form; (*c*) they must lie at right angles to the track of the sun; and (*d*) these clouds must, of course, be present in the immediate neighbourhood of the setting sun. There are, besides, certain atmospheric conditions which seem to be desiderated in order to favour opacity, as dryness of the air, with calmness in its movements, and, I believe, a comparatively high barometric pressure. At the time of my

observation of December 3, the relative humidity of the air was 75 per cent., the wind calm, and the barometer, corrected to 32° and sea-level, 30·284 inches. On January 7, relative humidity was 76·5 per cent., wind faint; barometer 30·499 inches. The altitude of this station is 480 feet; lat. 54° N., long. 1°.36 W. G. PAUL.

Corporation Observatory, Harrogate, March 24.

THE sun pillar described by your correspondents was very well seen from the railway between Netley (5.40) and Southampton (6 p.m.), and lasted, I think, more than half an hour. It was visible before and after sunset. The upper air at the time was remarkably calm; the morning had been foggy, and the morning of March 7 was also foggy on the ground. Observation of the upper clouds on the morning of the 6th, and at the time of the phenomenon, showed an extremely slow movement from the north-west, barely noticeable between telegraph wires overhead. At 9 a.m. on the 7th cirrus was moving very slowly from about north, and at noon from north-west.

R. RUSSELL.

Condercum, Alum Chine, Bournemouth, March 24.

THE accounts of this rather rare phenomenon (as it seems to be) come (so far) only from the south-west of England. It is, therefore, worth while adding the following as seen at Oxford by myself and friends:—

March 6, 6.18 p.m.—A vertical pillar of flame-coloured light, springing probably from the sun below the horizon, quite parallel-sided, about ⅜° wide and 6° high, careful measurements, perfectly steady for the 10 minutes that we were able to look that way. We thought there was a condensation of light, as of a faint mock sun, about 4° above the horizon. It was fading off downwards appreciably at the last moment.

Littlemore, Oxford. W. J. HERSCHEL.

IF the phenomenon of so-called "sun pillars" can only obtain when the atmosphere is "quite free from convection currents . . . (which it seldom is)" [see NATURE, March 20], is it not reasonable to suspect that the thing seen on March 6 was *not* such an atmospherical phenomenon? since it was viewed east and west from Brighton to the Cornish coast and northwards to High Barnet and Carmarthen Bay, so far as has been already ascertained.

If the barometrical and thermometrical readings, wind velocities and directions over this wide area on the 5th, 6th and 7th inst. could be obtained, an examination of these would go far to settle the question. CATHERINE O. STEVENS.

Bradfield, Berks, March 31.

Sounds Associated with Low Temperatures.

THE whistling or squeaking of snow under foot at low temperatures is a familiar phenomenon to residents in such climates as that of Canada. The sound is in strong contrast to the crunching of snow at the freezing point.

I suspect that "walking about the sheds" in the letter quoted by Sir Wm. Preece (p. 487) means walking over snow-covered ground between the sheds. J. D. EVERETT.

11 Leopold Road, Ealing, March 29.

I HAVE, I think, frequently heard the sounds mentioned in the letter sent to you by Sir William Preece; but if the sounds I mean are the same as those there described they are not necessarily associated with low temperatures, though they would be more likely to be noticed when the ground is frozen. The sounds to which I refer are to be heard near palings or sheds made, as they frequently are, with overlapping boards. The explanation I have always supposed to be as follows:—If the ground is sharply struck, with the boot for instance, the sound thus made will be reflected back by the ends of the boards; as each of these ends is further from the listener than its neighbour, the echoes will come back at intervals depending on the distance of the observer from the paling and on the width of the boards; if the boards are of equal width, the echoes will come back with nearly equal intervals between them, thus producing a musical note. If the ground is frozen, the sharp sounds necessary will be produced when walking by one's boot striking the ground; but the same sounds may be produced in dry weather and especially when walking on gravel. I have often observed the musical note, but never where such an explanation would not be possible. Wooden palings are not, however, necessary; I have heard the same thing when walking past iron palings, more particularly, as is to be expected, when the uprights have a square section. CHARLES J. P. CAVE.

Binsted, Cambridge, March 31.

CENTRAL AND SOUTH AMERICA.[1]

CENTRAL AMERICA and the West Indies are attracting so much attention at present that a comprehensive description of them is of especial value to all who are watching the growth of political power in the New World. Hence we may welcome Mr. Keane's work, which, *inter alia*, treats of their history, physical geography, climate, flora, fauna, ethnology and industries, as well as of their financial and commercial statistics. The volume, although purporting to be a "new issue," might well claim to have no relation to the old one, edited, a quarter of a century ago, by the well-known naturalist H. W. Bates; for the knowledge of the region which has accumulated during the interval has been largely utilised, although not brought up to date in some important respects. Besides ten carefully executed maps, not overloaded and confused by unimportant names, the work contains numerous illustrations.

Mr. Keane opens his subject with a comprehensive chapter on the physical and biographical relations of the countries under consideration. "The present Central American mainland, like the Southern continent, formed, originally, a vast insular region, which was gradually consolidated in Tertiary and later times. It constituted a great archipelago, which stretched, for about 770 miles, in a south-easterly direction from Tehuantepec to Panama, and presented certain analogies to the West Indian insular world, with which it is in fact connected by at least two chains of islets, reefs, and partly or wholly submerged marine banks. . . . It is difficult to realise the fact that the 'American Mediterranean,' as the Gulf of Mexico and Caribbean Sea are often called, has a circuit from Cape Sable round to the Bahamas of no less than 12,000 miles. . . . The volume of water (the Gulf Stream) rejoining the equatorial current north of Florida strait, though relatively small, forms none the less a liquid mass about fifty-five miles wide and 450 fathoms deep moving at the rate of from two to six miles an hour, and is thus equivalent to as many as 300,000 rivers as copious as the Mississippi." It may be remarked that Maury is contented with giving the flow of the Gulf Stream through this strait as 1000 times the volume of the mighty river mentioned.

Mr. Keane discusses at length the ethno-geographical relations of the almost numberless tribes which have made the lands bordering the Gulf of Mexico and Caribbean Sea such an interesting study, and he concedes to the Toltec, Aztec and Maya peoples a high degree of civilisation. Most writers do the same, as they let their imagination revel in the romantic accounts of the conquest of Mexico and the descriptions of the ruins found from New Mexico to Panama; but it may be doubted if any of the tribes of Indians who occupied that region ever reached a higher grade than the "Upper Status of Barbarism" so admirably defined by Lewis H. Morgan in his "Ancient Society."

As to the Carib race, the cradle of which Mr. Keane rightly fixes in the heart of South America, they wandered north to the shores of the Caribbean Sea, to which they gave their name, and which recognised, throughout its

[1] Stanford's "Compendium of Geography and Travel" (new issue). "Central and South America." Vol. ii. Central America and West Indies. By A. H. Keane, F.R.G.S. Edited by Sir Clements Markham, K.C.B., F.R.S. Pp. xxiv+496. (London: E. Stanford.) Price 15s.

islands and coast lands, their all-conquering predominance. In fact the Carib, a born navigator, was the connecting link between North and South America, and freely navigated the Gulf of Mexico and the Caribbean Sea for purposes of war or trade.

Commenting on the "pre-Columbian cultered Toltecs of Mexico," the author shows how these were pushed aside or driven southward by the invasion of the Nahuas from the north, who extended their conquests, by the Pacific coast, into Guatemala and Yucatan, and "penetrated beyond this region into Nicaragua, everywhere founding settlements amid the surrounding aborigines." But the Nahuatlacâ (Aztec) race really overran Central America as far south as the Isthmus of Panama. Vasquez de Coronado, in 1564, met a cacique, Iztolin, on the southern shore of Almirante Bay, who conversed with him in the Nahua tongue; and Ferraz has shown that numerous existing geographical names in Costa Rica are of Nahua derivation. But Panama was probably a debatable ground between them and the Indians of Colombia, or between them and the Caribs who occupied and crossed the isthmus and extended their raids to the Pacific coast of Colombia, which was populated by the Chocoamas. These, according to Codazzi, spoke Cueva, a mixture of Carib and Chocoama. That the Panama Indians were in communication with those of Nicaragua (which were, in turn, in contact with those of the Mexican tableland) is also proven by the first Spanish exploring expedition sent northward (1516) from the Pacific side of the isthmus, near which they found a large bay, where the Chinchiris Indians gave the information that there was a communication between the two oceans through a great interior lake (Nicaragua).

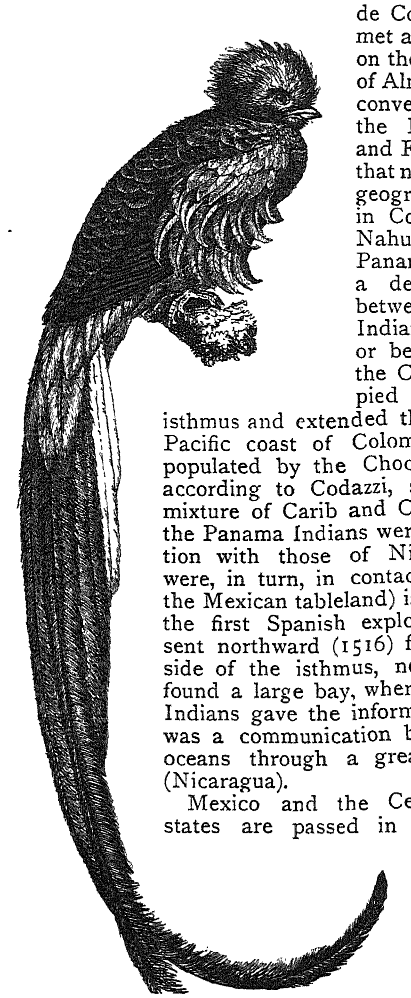


FIG. 1.—Quetzal.

Mexico and the Central American states are passed in review by Mr. Keane, and their history, geography, physical features, &c., receive such attention as is possible within the limits of the volume. Regarding the history of the first, he says, "the endless revolutions and political disorders of all sorts which followed the War of Independence produce a sense of weariness accompanied by a feeling of surprise that the Mexican people could have ever recovered from such a succession of overwhelming calamities." This is true; but it would have been useful to state that almost all of these revolutions represented the struggle of the Liberal party to shake off the baneful grip of the Church, which, in 1827, had 150 convents scattered over Mexico, and, in 1833, held more than one-third of the country in mortmain. Moreover, Europe was responsible for aiding the clergy in the last grand struggle of the latter to retain their power, through the establishment of an Imperial Government under Maximilian, backed by a French army. It was the most terrible and desolating war that Mexico ever saw; but the effort of the Church was a disastrous failure—the greatest of Mexicans, the Indian Juarez, was the victor, and the Constitution of 1857 and the Laws of Reform of 1859 remained triumphant, and became the basis of the subsequent remarkable progress of the country.

Quoting a careless writer, Matias Romero, Mr. Keane gives Mexico 15,000,000 inhabitants and estimates the whites at 19, the aborigines at 38 and the mixed at 43 per cent. of the population; but such statements are only based on personal judgment. I should be inclined to estimate the aborigines at at least one-half of the entire population. It is a question if the aboriginal blood is not stronger than the Spanish, and if it will not, in the long run, aided by climate and environment, *indianise* the latter, unless arrested from the north.

Remarking on the mineral wealth, Mr. Keane gives the total mintage of Mexico since 1537 at 706,000,000*l*. This is probably understated; the eminent statistician Miguel Lerdo Tejada, in 1853, in an elaborate statement, gave the total amount coined, from the conquest up to 1852, at 3,562,204,897 dollars (pesos), of which 110,000,000 dollars remained in the country. The amount exported did not include contraband shipments of uncoined silver, which were enormous.

It is impossible within the reasonable limits of a review to comment upon all the interesting and varied data contained in Mr. Keane's valuable book. Some of the countries, however, of which it treats have already outgrown it; Spanish America, with all its turmoil, moves faster than Europe. In speaking of the two principal Atlantic ports of Mexico, Mr. Keane says that below Tampico, "six miles above the mouth of the Panuco river, this is so shallow that vessels drawing over nine feet have to ride at anchor outside the bar"; and as to Vera Cruz, "there is no harbour at all. . . . Vera Cruz should certainly have been founded at Anton Lizardo, fifteen miles further south, which has the only good harbour in the Gulf." These statements should be modified somewhat; the bar of Tampico has been deepened, and admits ships drawing twenty feet of water. The total net register tonnage of vessels entering the port now exceeds that of Vera Cruz. The fine port works of the latter (enclosing an area of nearly a square mile) give safety for ships of heavy draught. As to Anton Lizardo, as a harbour, its safety against "northers" could only be assured by building a very long breakwater on the reef which partially protects it and which is only visible at low water.

Reaching the Central American States, the author properly describes Guatemala as "almost an Indian republic." Here the population double their chances for the efficacy of prayer by worshipping at a Christian altar with images of their heathen deities hidden behind it. The physical features of the country, its products, character of its people and their Government are similar to those of the densely populated contiguous state of Salvador. Honduras, which has been the victim of financial depredations from abroad rivalling in magnitude its almost unequalled natural resources, is well and vividly outlined. It is the richest in mineral wealth of all the Central American States. Nicaragua and Costa Rica are treated at some length. The former is distinguished by three physical zones:—"(1) the Mosquito seaboard, partly of coralline (marine), partly of alluvial formation; (2) the uplands of the interior, with the Cordillera de los Andes forming part of the original continental framework, and extending from Mosquitia to the great depression which is now flooded by lakes Nicaragua and Managua; (3 the coastlands between the lakes and the Pacific, which are mainly of igneous origin and form a southern continuation of the Salvador volcanic system. . . . Thanks to a

mean altitude of from 2000 to 3000 feet above the sea, the central uplands, including the Atlantic slopes of the Nicaraguan backbone, enjoy a relatively mild climate, generally healthy and suited for European settlement." Of Costa Rica, "probably 275,000, out of a total population of 294,000, have already been fused in a somewhat homogeneous Ladino element of Spanish speech and culture. As in Salvador and Nicaragua, the people are concentrated in the fertile and salubrious volcanic districts on the Pacific slope." Mr. Keane's description of the principal West Indian islands is admirable and varied, and enables the reader to understand their importance in the general movement of the world; but the voluminous publications of the United States Government, in 1900, relative to Cuba and Puertorico, might have been consulted with advantage. Saving the defect that much of the industrial, financial and commercial data are not brought up to date, the volume is an extremely useful and instructive compendium of the subjects of which it treats, and does great credit both to the publisher and the author. One of the illustrations is reproduced on the preceding page. GEORGE EARL CHURCH.

THE MALDIVE AND LACCADIVE ARCHIPELAGOES.[1]

FEW oceanic island groups are of greater interest to the students of the science of "distribution" than the Laccadives, Maldives, Chagos and Seychelles, since they appear to be the last remnants of a land connection between India and Madagascar. For instance, Dr. W. T. Blanford, in his presidential address to the Geological Society for 1890, after mentioning that there appeared to be evidence of deep water between the banks on which the above-mentioned islands are situated, proceeded to say that he believed a fuller knowledge of the contours would reveal the existence of a bank connecting the whole series from India to Madagascar. "Even should this not be case, the evidence of a land-connection appears so strong that it may be a question whether the whole of the ocean-bottom between Africa and India may not have sunk to its present depth since Cretaceous times."

In addition to this special point of interest, the coral-reefs of the Maldives, Laccadives and Ceylon have an interest of their own in regard to their mode of formation and growth, the fauna by which they are inhabited, and the evidence they afford either of upheaval or of subsidence in this part of the Indian Ocean. The managers of the Balfour studentship, with the assistance of donations from the Government Grant Committee of the Royal Society and the British Association, were therefore well advised in selecting this area as one where a careful and detailed geographical and zoological survey would be likely to yield results of the highest scientific importance. So far as can be judged from the small section of the work now before us, Mr. Gardiner, ably seconded by Messrs. Borradaile and Cooper, appears to have carried out his task with great thoroughness and success. A part of the time, it is true, he was incapacitated from work by illness, but during his absence the researches were carried on with vigour by Mr. Cooper, who took no less than eighty-eight dredgings in five different atolls.

[1] "The Fauna and Geography of the Maldive and Laccadive Archipelagoes, being the account of the work carried on and of the collections made by an expedition during the years 1899 and 1900." Edited by J. S. Gardiner. Vol. i., part i. (Cambridge: University Press, 1901.)

Until the appearance of the complete work, which we gather will run to at least two volumes, we cannot, of course, lay before our readers the editor's conclusions with regard to the important problem mentioned at the commencement of this article. Neither can we refer to the general *facies* of the fauna of these islands. Our notice must accordingly be restricted to the general introduction to the work and the four chapters which (together with a description of certain sections of the fauna) constitute the part before us.

For reasons connected with the meteorological conditions prevailing in the Indian Ocean, it was decided to devote the summer of 1899 to a thorough survey of Minikoi, the most southern atoll of the Laccadives. This island forms the subject of two out of the four chapters already published, and its history is to be continued in those which follow.

In the introduction, Mr. Gardiner refers to the enormous numbers of the delicate shells of the cephalopod Spirula met with on the northern end of one island. On inquiry from the natives he found that they were quite familiar with the complete mollusc, which appeared in numbers during the winter of 1897. Strangely enough, however, the creature seems to be extremely local, since it is quite unknown to any of the other islanders.

In the chapter on its coral islands, the author remarks that the Indian Ocean gives little clue from its topography to the character of the foundations of the various groups; and in this respect is unlike the Pacific, where the groups run more or less nearly parallel to one another and to the adjacent continent. In one respect the two oceans present a striking similarity, namely, in the absence or paucity of coral-islands on their eastern[1] sides. In the Pacific this absence is complete; in the Indian Ocean it is broken only by Cocos-Keeling and Christmas Islands. In the Indian Ocean this scarcity of islands on the eastern border is, so far as it goes, in favour of the view that the numerous islands on the western side formed part of a land-connection. This belt between Madagascar and India is cut, says the author, to a depth of more than 2000 fathoms in three places, to wit, between the Maldives and Chagos, between the latter and Saya de Malha Bank, and again between Farquhar Atoll and Madagascar. "These channels divide the coral-reef areas into four sections, which may be respectively termed the Malagasy, Seychelles, Chagos and Maldive." These four sections are then discussed in detail.

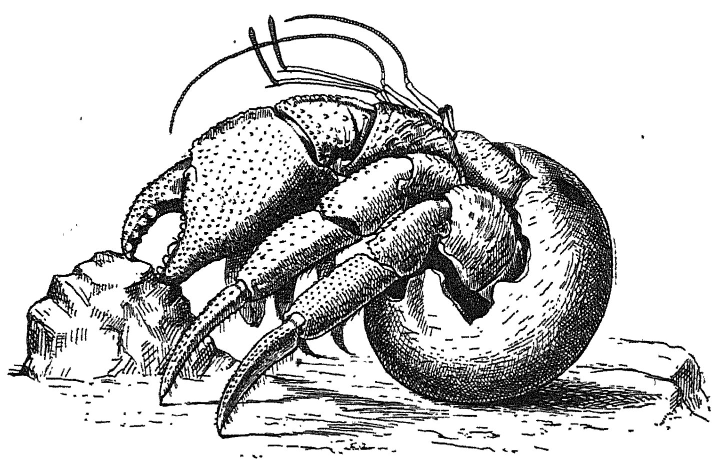


FIG. 1.—*Coenobita clypeatus* using a broken cocoanut as shell.

Chapters iii. and iv. are devoted to part of the descrip-

[1] The author writes "western," but he obviously means "eastern."

tion of Minikoi, of which a map is given. Although at one point the land is gaining on the lagoon, in others it is gradually diminishing, and the author prophesies that in course of time the sea will make a clean sweep of some parts of the atoll.

Much attention is devoted to the mode of formation of a coral conglomerate found in Minikoi and elsewhere at the base of the outer beach. From the presence of this conglomerate and other evidence, the author concludes that an elevation of at least 24 feet must be admitted to have taken place in Minikoi, and this during the time that it has existed as an atoll. "The presence of conglomerate masses," he adds, "I can only regard as indicating the existence of former land in any position where they now occur. The land there must have at one time extended round the whole island with only a single break, perhaps to the north, with lower parts here and there, where boat-channels across the reef now exist." Minikoi was indeed once apparently very like some of the low coral-islands of the Maldive group in the Indian Ocean and the Ellice group in the Pacific. For the final chapters on Minikoi we must await another fasciculus of the work.

The groups of the Minikoi fauna included in this fasciculus comprise the Hymenoptera, by Mr. P. Cameron; the land crustaceans, by Mr. L. A. Borradaile; and the nemertean worms, by Mr. R. C. Punnett. Among the second of these perhaps the most generally interesting group are the land hermit-crabs of the genus Cœnobita. Like the great cocoanut crab (*Birgus latro*), these crabs have forsaken the sea for a life on land, although (unlike the former) they still retain the habit of sheltering the abdomen within a shell or some such covering. In the case of a specimen of which the figure is here reproduced, the abdomen is encased in the broken shell of a cocoanut. Among the nemertean worms, a genus hitherto known only from Amboina has been met with again at Minikoi. R. L.

PROF. MAXWELL SIMPSON, F.R.S.

Maxwell Simpson, ninth and youngest child of the late Thomas Simpson, was born at Beech Hill, co. Armagh, Ireland, on March 15, 1815. Educated at a private school in Newry, he thence proceeded to Trinity College, Dublin, where he took his Arts degree, and subsequently entered the School of Medicine. In 1847 he graduated as Bachelor of Medicine in Trinity College; but already he had been strongly attracted towards the study of chemistry, and instead of settling down to the practice of physic, he now became associated, as lecturer in chemistry, with the medical school of Park Street, Dublin. This school had been established about 1824 by a number of physicians and surgeons, and had included among its teachers James Apjohn, subsequently professor of chemistry in the University of Dublin. From Park Street he was transferred to the Peter Street School of Medicine, where he remained for a few years.

Inspired, however, by a profound love for science, the limitations incidental to such a post grew irksome to him; the desire to secure adequate outlet for his intellectual energies, to prosecute his own inquiries, and to enjoy the communion of fellow-workers intensified with time, until finally, casting aside all material considerations, he relinquished his teaching and proceeded to the Continent, where, associated with some of the most eminent chemists of the day, he was free to breathe the congenial atmosphere of research.

Plunging with characteristic energy and enthusiasm into work, he soon became productive. In 1851 he studied with Kolbe at Marburg, then under Bunsen at Heidelberg, conducting in the laboratory of the latter an investigation on which his first original paper was based; this communication, "On two new Methods for the Determination of Nitrogen in Organic and Inorganic Compounds," published in the *Journal* of the Chemical Society (vi. 289) and in the *Annalen der Chemie und Pharmacie* (xcv. 63), foreshadowed the accuracy and thoroughness which were to mark his later work.

Moving next to Paris, and entering the laboratory of Wurtz, his attention naturally became centred on organic chemistry, and here his capacity for work was quickly manifested; commencing with a paper on the "Action du Brome sur l'Iodure d'Aldéhydène," read before the Académie des Sciences on March 1, 1858, one memoir followed another in rapid succession. In April he made a communication "Sur une Base nouvelle obtenue par l'action de l'Ammoniaque sur le Tribromure d'Allyle," another on the same subject in August, and a third in November on the "Action du Chlorure d'Acétyle sur l'Aldéhyde"; these he followed up by two papers (*Proc.* Roy. Soc., ix. 725 and x. 114) "On the Action of Acids on Glycol." On April 25, 1861, Prof. Frankland communicated, on his behalf, to the Royal Society the first of two important papers "On the Synthesis of Succinic and Pyrotartaric Acids," in which he showed that the former, built up from ethylene, through the dibromide and corresponding cyanide, is identical with common succinic acid; the latter, from propylene bromide, with the pyrotartaric acid got by distilling natural tartaric acid—thereby establishing the chemical constitution of both. This excellent piece of work met with due recognition, and in 1862 Maxwell Simpson was admitted a Fellow of the Royal Society.

Two other communications appeared (*Proc.* Roy. Soc., xi. 590 and xii. 278) "On the Action of Chloride of Iodine on Iodide of Ethylene and Propylene Gas," and, almost concurrently with these, two more, now classical, "On the Synthesis of Tribasic Acids" (*ibid.* xii. 236, and *Journ.* Chem. Soc., 2, iii. 331); here it was shown that from allyl tribromide, a corresponding tricyanide can be obtained, which by saponification yields a salt of tricarballylic acid—this substance is an immediate derivative of glycerine, and "bears the same relation to citric acid that succinic bears to malic acid."

It is not possible within these limits of space adequately to notice Simpson's work or its bearing. Of his further papers may be mentioned: "On the Acids that may be derived from the Cyanides of the Oxy-radicals of the Di- and Tri-atomic Alcohols"; "On the direct Transformation of Iodide of Allyle into Iodide of Propyle"; "On the Action of Chloride of Iodine upon Organic Substances"; "On the Formation of Di-iodacetone"; "On the Formation of Succinic Acid from the Chloride of Ethylidene"; "On a new Compound formed by the direct union of Aldehyde and Anhydrous Prussic Acid" (with Dr. Gautier); "On the direct Transformation of Chlor-iodide of Ethylene into Glycol"; "On some new Derivatives of Acetone"; "On the Brom-iodides"; "On the Determination of Urea by means of Hypobromite of Soda" (with Mr. C. O'Keeffe), and a paper (*Proc.* Roy. Soc., xxvii. 120) "On compounds of Silver Iodide with Alkyl Iodides." Of the above work, that described in the paper on aldehydes and hydrocyanic acid is especially important, leading, as it did, to the synthetical production of one of the forms of lactic acid.

In 1872, Maxwell Simpson was appointed to the chair of chemistry in Queen's College, Cork, an office which he resigned after nineteen years of service.

His power was by no means confined to the research laboratory; as a lecturer he possessed in a high degree that gift of luminous exposition which is the product of quick and accurate memory, clear intelligence and ready command of language. Simple and unaffected, genial of manner, though strong in the courage of his convictions; direct and original in thought and speech, Simpson's

personality was forceful, interesting and lovable. Endowed as he was, it may seem strange that he did not establish a school of chemistry in Cork. But the reason is not to be found in the man—rather in his surroundings. Placed, as he was, in a sparsely populated district, where poverty is, unhappily, the rule, where chemical manufactures are but few, and where the demand for highly trained chemical knowledge of any sort is practically non-existent, the result flowed almost inevitably from the conditions.

At various times he acted as examiner in chemistry to the Civil Service of India, the Civil Engineering College, Coopers Hill, and the Royal Military Academy, Woolwich; he was an Honorary Fellow of the King's and Queen's College of Physicians; received the degrees of M.D. and LL.D. (both *honoris causa*) from the University of Dublin; was a senator of the Queen's University; Fellow of, and examiner in, the Royal University of Ireland, from which he received the degree of D.Sc. (*honoris causa*); he was also selected as president of the section of chemistry of the British Association at its meeting in Dublin in 1878. In addition, he was for several years a member of the council of the Chemical Society, by which he was elected, during the years 1872–74, to the office of vice-president.

On February 26, Maxwell Simpson passed away in London; his work remains, a worthy and enduring memorial to his love for that science which he so generously enriched. A. E. DIXON.

NOTES.

PROF. E. C. PICKERING announces that he has received from a friend a gift of twenty thousand dollars (4000*l.*) for the benefit of the Harvard College Observatory. It is proposed to expend about one-half of this fund in extending the present building in which the astronomical photographs are kept, so as to provide for the adequate storing of this collection with its probable increase for many years. These photographs furnish a history of the entire stellar universe for the last twelve years, and is not duplicated elsewhere. A portion of the remainder of the gift will be used at once to provide for the study of objects of interest on the photographs, as hitherto only those of special importance have been examined.

THE Raoult Memorial Lecture of the Chemical Society was delivered by Prof. van 't Hoff on Wednesday of last week. Shortly after Raoult's death, a year ago, a short account of his career was given in these columns (vol. lxiv. p. 17). Prof. van 't Hoff remarked that the scientific work could be conveniently considered as belonging to three periods of Raoult's life—physical, chemical and physiological. As a typical research of the first period he mentioned the study of the heat evolved by chemical reactions in the voltaic cell and that due to the electric current. Later, Raoult directed his attention to subjects of a more purely chemical nature, such as the influence of solar radiation on the inversion of cane sugar, and the absorption of ammonia by saline solutions. His physiological work included studies of the presence of copper and zinc in the animal organism and the influence of carbon anhydride on respiration. But Prof. van 't Hoff pointed out that the researches which made Raoult's name famous as a scientific investigator were those which led to the establishment of a definite connection between the lowering of the freezing points and of the vapour pressures of solvents by the presence of dissolved substances. This led Prof. van 't Hoff to the important generalisation that the osmotic pressure of a dissolved substance bears a definite relationship to the pressure it would exert if it were in a state of vapour—a theory which has been of immense service in elucidating the nature of solutions and has also led to the theory now widely accepted as to the existence in dilute salt solutions of the ions of the dissolved substance.

WE regret to see the announcement of the death on Good Friday of Mr. G. F. Wilson, F.R.S., whose scientific work included the discovery of the means of obtaining pure glycerine, and numerous papers on horticultural subjects. Mr. Wilson was in his eightieth year.

LORD KELVIN is expected to arrive in New York on April 19. *Science* states that a reception will be given in his honour on the evening of April 21 by Columbia University, the American Institute of Electrical Engineers, the New York Academy of Sciences and other scientific societies.

ON Tuesday next, April 8, Dr. Allan Macfadyen will deliver the first of a course of three lectures at the Royal Institution on "Biological Inquiry"; on Thursday, April 10, Prof. Dewar will begin a course of three lectures on "The Oxygen Group of Elements." The Friday evening discourse on April 11 will be delivered by Prof. Dewar on "Problems of the Atmosphere," and on April 18 by Sir John H. A. Macdonald, his subject being "The Autocar."

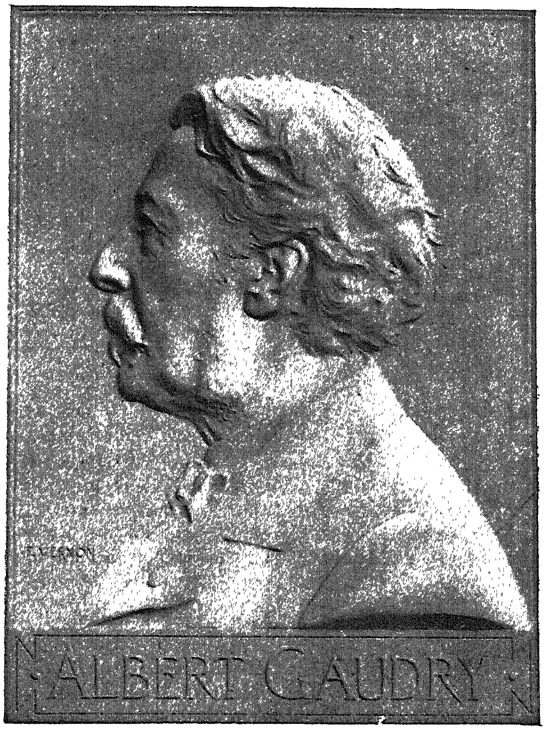
THE Berlin correspondent of the *Times* states, upon the authority of the *Lokalanzeiger*, that a scheme is under consideration by the German Imperial authorities in accordance with which the chief commercial nations, especially England, France and the United States, will be invited to send representatives to an international congress, the object of which will be to arrive at an agreement forbidding the establishment of any monopoly in wireless telegraphy on the high seas. This step, it is stated, is the direct consequence of the refusal of the Marconi station on the Nantucket lightship to enter into communication with the *Deutschland* during its homeward journey with Prince Henry of Prussia on board.

WE learn from the *Times* that the University of Chicago has commissioned Mr. Alleyne Ireland to report on the financial, commercial and social conditions of all the European colonies in the Far East, where the circumstances appear both geographically and historically to bear some resemblance to the general situation of the Philippines. Mr. Ireland will visit Burma, Siam, the Federated Malay States, the Straits Settlements, Sumatra, Java, British North Borneo, Sarawak, French Indo-China, Tonking, Formosa and Hongkong. After making an investigation of the general condition of the Indo-Malayan people under British, Dutch, French, and native rule, he will then go to the Philippines in order to examine the conditions of those islands from the comparative point of view. It is anticipated that his inquiry will occupy about two years.

AT the request of the U.S. Senate, the Secretary of Agriculture has reported upon the condition of the American bison. In his summary he states that this species is on the verge of extermination. Scarcely a handful now remain of the millions which formerly roamed over the plains of the west. Only two small herds of wild buffalo are in existence in the United States—one in the Yellowstone Park, the other in Lost Park, Colo. There are no wild buffalo in Canada, except in the Peace river country, where a few woodland buffalo, believed to be a different species from the American plains buffalo, still exist. A number of buffalo have been domesticated and half-domesticated, there being three important herds in addition to the small herds in zoological parks and in the hands of private individuals. It is suggested that if the Government would acquire possession of a considerable number of full-blooded animals the absolute extermination of the species might be long delayed.

The fourteenth International Medical Congress will be held at Madrid on April 23-30 of next year. The *British Medical Journal* states that in almost all the countries of Europe and America local organising committees have been formed. The Spanish Minister for Foreign Affairs has invited all Governments to send representatives. A similar invitation has been sent to all universities and medical schools, and to the principal medical societies in all countries. Among the numerous applications for membership which have up to the present been sent in are the names of eighty-five delegates, and there is every prospect of a most successful meeting. Among the notabilities of the medical world who have promised to deliver addresses are Profs. Pavlov, Maragliano, Thomson, Laache, Waldeyer, Cajal and others. Almost all the various sections have arranged their programmes of discussions, and they are now grappling with the task of selecting men to open them. A preliminary programme, including not only the official list of discussions, but the titles of communications offered, will shortly be issued.

As already announced, the jubilee of the scientific career of the eminent palæontologist, Prof. A. Gaudry, was celebrated at Paris on March 9, when many of his old pupils, friends and admirers assembled to do him honour and to offer him a medal commemorative of his services to science. Delegates were present from numerous learned societies and académies, including our own Royal Society; and addresses were delivered by M. E. Perrier, director of the Natural History Museum, where the celebration was held, M. M. Boule and M. Liard. The accompanying illustrations from *La Nature* show the medal which was presented to Prof. Gaudry as a slight mark of appreciation of his work in palæontology and the honour it has brought to France and to the museum with which he has been so long connected as student, assistant naturalist and professor.



The Russian Geographical Society has sustained another heavy loss by the death of General Mikhail Vasilievich Pyevtsoff. He was born in 1843,[1] received his education in a military school, and next in the Academy of the General Staff, and after having finished his studies remained for fifteen years at the General Staff at Omsk, making important journeys in Dzungaria and north-western Mongolia. He also took part in the great surveys which were made in 1880 on Chinese territory in connection with the tracing of the boundary between China and Russia. The results of the first two journeys were embodied in papers published in the *Memoirs* of the West Siberian Geographical Society, the description of north-western Mongolia, by Pyevtsoff, being the best work on the subject. In 1888, after the sudden death of Prjevalsky, Pyevtsoff was nominated head of the Tibet expedition, and, in company with Roborovsky and Kozloff and the geologist Bogdanovich, he explored during two years eastern Turkestan and the Gobi—the results of these explorations being now embodied in three quarto volumes edited by the Russian Geographical Society. Pyevtsoff also contributed to theoretical geodesy an important paper on the determination of latitudes from the corresponding altitudes of two stars—a most useful extension of M. Tsinger's method, which has been largely applied since by Russian explorers in Central Asia—and another on barometrical levellings.

The series of Saturday afternoon excursions of the London Geological Field Class, conducted by Prof. H. G. Seeley, F.R.S., will commence on April 26, when a visit will be paid to Erith. The excursions will be continued on each succeeding Saturday (except on Saturdays before Whitsuntide and in Coronation week) until July 12. Further particulars can be obtained from the hon. general secretary, Mr. R. Herbert Bentley, 43 Gloucester Road, Brownswood Park, N.

Dr. H. R. Mill has collected observations relating to the frost of February last from all available sources, and has published in Symons's *Meteorological Magazine* for March an interesting summary of the results, with a sketch-map which shows diagrammatically the number of days of frost in different parts of the country. With the exception of the long-continued cold of

February 1895, the recent frost was the most prolonged and severe that has been experienced in February for half a century. Dr. Mill measures the duration of the frost by the number of nights during which the temperature in the shade fell below the freezing point. In most places the cold weather set in on the 1st, and, generally speaking, lasted for three weeks, except on the sea coasts. For instance, at Torquay the period was nine days, at Eastbourne and some other places twelve days only, while in Suffolk, Yorkshire and Peebleshire the frost lasted for twenty-four days. The lowest shade temperatures were $-2°$ at Lairg (Sutherland) and 0° at Braemar on the 14th. At Camden Square the minimum was 15°·8, the only lower records there in February being 15°·4 in 1865 and 7°·3 in 1895. The mean temperature of the month appears to have been from 3° to 5° below the average in all parts of our islands. Heavy snowfalls occurred in the north and west, but in the south-east there was an almost entire absence of precipitation during the period of the frost.

THE *Scientific American* for March 8 describes and illustrates a very novel form of flying machine which has been devised by M. Henri Villard, of Paris. The machine has not yet been ried, so at present nothing can be said about its capabilities, but the inventor hopes to carry out the first trials next spring. An idea of the apparatus may be perhaps best explained by imagining a rather flat umbrella of considerable size made rigid by an exterior steel rim and wire spokes. On the stick portion of this large umbrella, and under the umbrella, are two pro-ecting arms, one carrying a screw to move the apparatus in a horizontal direction, the other a rudder for steering purposes. Still lower down on this stick, on one side of it, say near the handle of the umbrella, is the motor, and opposite it the seat for the operator. The motor has two functions, one of which is to drive the screw for obtaining the horizontal motion, and the other, which is the novel part of this form of flying machine, for rotating at a rapid speed the umbrella portion. The idea is that the rapidly rotating umbrella with the comparatively heavy rim will act like the wheel of a gyroscope, and that this will tend to keep the machine from being easily moved out of the plane of rotation. The umbrella portion, which is practically a parachute, is a large flat wheel of twenty-two feet external diameter, resembling somewhat a bicycle wheel, the rim of which is made of half-inch diameter circular steel tubing, and this is covered on its upper portion with stout cotton balloon canvas. The parachute or wheel portion is not really a true wheel, but built on the plan of a helix, so that by rapid rotation the whole apparatus can be lifted vertically; it is stated that this will absorb about four horse-power.

AN ingenious and very convenient method for finding the velocity of underground water is described by Prof. Slichter in the *Engineering News*. The method is an electrical one, and consists in determining the time taken for an electrolyte to travel along a certain length of the stream. A double row of 1¼ inch drive wells is sunk across the channel of the stream and the upstream wells are charged with a solution of an electrolyte, ammonium chloride having been found very suitable. The electrolyte flows down stream with the moving water, and its arrival at the second row of drive wells is indicated electrically. The best method of connecting up the electrical indicator is said to be the following. One pole of the battery is connected to the outer sheathing of the lower well tubes through an ammeter; the other pole is connected to the upstream tubes and also to an insulated electrode passing down the centre of the downstream tubes. A gradual rise in current marks the passage of the electrolyte down stream; when it arrives at the lower row of wells, the resistance of the circuit between the sheathing and the inner electrode is so much diminished that a sudden kick of the ammeter occurs, marking with great precision the time of arrival. The second circuit may be dispensed with, but the moment of arrival is not in that case so sharply marked. A number of preliminary tests have been made on the rate of movement of the underflow of the Arkansas River, and a more extended and systematic survey is now being undertaken.

IN a paper recently contributed to the Royal Dublin Society, Prof. Johnson, of the Royal College of Science, directs attention to the great injury done by "smut" (*Ustilago avenae*, Jens.) to the oat crop in Ireland, and as the result of two years' experience strongly recommends the use of an American fungicide, "Sar." Sar—so-called because of the ingredients, sulphur, alkali and resin, used in its preparation—consists chiefly of sodium sulphide, and to this compound the fungicidal properties are due. Sar can be made at a cost of 6*d.* to 9*d.* per pint; and one pint in 30 to 40 gallons of water will cleanse 4 bushels of seed. The grain must be soaked for 24 hours, and for ordinary farm use it would be necessary to provide a tank capable of dealing with one day's supply of seed, say 30 to 50 bushels. Smut is a widespread pest in Britain, but partly because in normal seasons it does not do serious damage, and partly because of the unsuitability of the farmer's ordinary "steep" (solution of copper sulphate) and the trouble attending the use of Jensen's "hot-water" method, few attempts have hitherto been made to deal with the fungus. Prof. Johnson's paper should secure an extended trial for sar in Wales, the west of Scotland, and other moist districts where *Ustilago avenae* is common.

FOLLOWING the example set more than a decade ago by the Government of New South Wales, the Agricultural Department of the Government of Victoria has begun the issue of a monthly journal. In the first part, dated January 1902, the scope of this publication is indicated in an introduction written by the Hon. John Morrissey, M.L.A., Minister for Agriculture. The chief function is to bring the officers of the Department into closer touch with the agricultural population. A considerable body of information is accumulated by the experts employed by Government, and it is felt that unless this information is in active circulation it will prove of little value. An annual report does not meet the farmer's requirements, for "the annual must ever be largely a review, which in daily practice is not so much wanted as the forecast, and this the journal will aim to furnish." The thirty or so articles and notes contributed to the first number by the officers of the Department are direct, practical, freely illustrated, and well calculated to assist the agriculturist. They deal with such subjects as uses of demonstration plots, registration of remounts, best types of vat for wine-making, cream-testing, and inspection of exported butter. The journal is under the editorship of Mr. H. W. Potts. It is well arranged and well printed. It promises to be of much value to the colony.

THE British Mycological Society has just issued its transactions relating to the week's fungus foray held at Exeter in September of last year, and the papers read at the evening meetings. The most successful find was *Femsjonia luteoalba*, a genus belonging to the Tremellineæ, and one up to that time unrecorded for Britain. It was found growing on oak and birch. A paper was read by Mr. B. T. P. Baker, of Cambridge, giving some results of his cultures with Saccharomyces, which were undertaken to determine the conditions regulating spore formation. The cultures were made on plaster of Paris blocks treated with various solutions. The results seem to confirm the views put forward by Heinsen that aeration is the most important condition which regulates the production of spores. The amount of food present is also another determining factor and one which reacts differently with the two species, *S. cerevisieae* and *anomalus*, with which Mr. Baker experimented.

S. cerevisieae forms spores when it is starved, but *S. anomalus*, contrary to the generally accepted ideas, gives a bigger spore yield as the amount of food is increased. Botanists who wish to obtain spores for class work or otherwise will also do well to note that cells of the yeast will only give a good supply of spores when they are about twenty-four hours old, and none at all when they are two days old or more.

PROF. MARSHALL WARD, F.R.S., has summarised for the British Mycological Society a few of the important results which he has obtained in the course of his studies on the susceptibility of different species of brome-grasses to the attacks of the rust fungus (*Puccinia dispersa*). The development of the fungus from the uredospore when taken from one species of Bromus and transferred to another species is found to differ according to the relationship of the two Bromes. If these are closely related, the fungus infects and grows rapidly, whereas a more remote species may be entirely immune from infection. By means of carefully devised apparatus, Prof. Ward has raised pure cultures of grass from sterilised seed in germ-free tubes, and has thus been able to demonstrate that seeds from infected plants are entirely free from disease, thereby proving fairly conclusively the impossibility of intra-seminal sources of infection.

A "CATALOGUE of Altitudes in Asiatic Russia and some adjacent Portions of Asia, on the Basis of Materials Published up to 1894," by Dr. K. Hikisch, appears in the *Memoirs* of the Russian Geographical Society (General Geography, vol. xxxi., 2). The catalogue contains a very valuable list of 11,629 determinations of altitudes in Asiatic Russia, as also in Russian and Chinese Turkestan, Mongolia and Manchuria, published in the same form as they were issued by the respective authors. Unfortunately there remains still an uncertainty of about 100 feet in the altitudes of the fundamental points for most determinations—Irkutsk in Siberia and Tashkend in Turkestan. An alphabetical index of all the names considerably facilitates reference to this catalogue.

MR. JOHN CADMAN has prepared a useful account of the occurrence, mode of working and treatment of the ironstones found in the North Staffordshire Coal-field (*Trans.* Inst. Mining Engineers for 1901). The blackband ironstones occur in the upper portion of the Coal-measures beneath the Etruria Marls; they overlie seams of coal, and the thickness of the coal frequently varies in inverse ratio to the thickness of the ironstone. Sometimes the ironstones assume the nature of cannel coal, and occasionally they pass into limestone. Many fossils have been found in the ironstones, and notably through the researches of Mr. John Ward, but the mollusc Anthracomya is the prevailing shell.

THE geology of the "Riukiu Curve," or of that series of islands which lies between Formosa and Kyūshū in Japan, has been dealt with by Prof. S. Yoshiwara (*Journ.* Coll. Science, Tokyo, Japan, vol. xvi. 1901). The principal rocks of the islands are of Palæozoic age, and comprise slate, sandstone, quartzite and limestone, with amphibolite and schalstein. The ancient sedimentary rocks dip steeply to the west, and are penetrated in places by masses of granite and diorite. They form a median zone in the series of islands. The inner zone in the curve is formed mainly by volcanic rocks, and the outer zone by Tertiary strata of Miocene and later stages, which contain coal-seams and are here and there rather irregularly inclined. Raised coral-reefs are found in various districts, and these are quite horizontal. The maximum elevation of the reefs is 684 feet; they exhibit a character like those now growing in adjacent seas, and they have been upheaved after a gradual depression. The formation of the curve has been explained by Prof. Kotô as due to the depression of the "East Sea" of China, which took place for the most part in the Tertiary period. The volcanic rocks appear to belong to somewhat different stages in that period and to have originated along a great fissure which is continued in the volcanoes of Kyūshū.

THE Royal Zoological Society of Ireland has published a short account of its origin and early history. The author, Dr. D. J. Cunningham, has to lament the absence of documentary evidence, or the extreme incompleteness of such evidence, as to much of the early history of the Society; but in spite of this he has managed to bring together a number of interesting facts in connection with its foundation, and also gives portraits of some of the most prominent among the founders. The Society was established in May, 1830, at a meeting presided over by the Duke of Leinster, Dr. Whitley Stokes being elected the first hon. secretary at the second meeting, held later in the same month. It is interesting to note that the eminent ornithologist Mr. N. A. Vigors, who three years later became the first hon. secretary of the London Zoological Society, took a prominent part in the organisation of the Dublin institution.

OF the five articles included in part iv. of vol. xxix. of Gegenbaur's *Morphologisches Jahrbuch*, four are devoted to mammalian anatomy. In the longest, Herr G. Ruge discusses the varieties of form displayed by the liver of the Primates. The author considers that the mammalian liver was always divided into lobes, and was never, as has been suggested, a simple organ. Some emendation is made in the nomenclature of the lobes, and the homology of the aberrant "spigelian" and "caudal" lobes worked out. In another article, Dr. E. Stromer considers the morphological importance of the foramen found at the lower end of the humerus of many mammals and likewise of the third trochanter of the femur. From its occurrence in so many of the lower types, the entepicondylar foramen, as it is called, is regarded as a primitive structure, of which the original object was to protect certain nerves and blood-vessels. It is remarkable that it should persist in the spectacled bear of the Andes, although it has disappeared in all other living members of the group. The third trochanter of the femur, on the other hand, can scarcely be regarded as primitive, seeing that it is wanting in several of the lower groups of mammals. Neither can its presence be attributed, as Gaudry suggests, to the reduction in the number of the toes, as otherwise it should not be found in the rhinoceros. Its general absence in man forbids the idea of its having any connection with the upright posture.

THE important position occupied by the science of bacteriology in the United States may be gathered from the existence of an American Society of Bacteriologists, which has already held no less than three annual meetings. The last meeting of the society's members was held at the end of last and beginning of this year in Chicago, and a recent number of *Science* contains abstracts of the papers read. A great variety of subjects was dealt with, amongst which dairy bacteriology is well represented by contributions from Mr. H. L. Russell amongst other well-known authorities in this branch of applied bacteriology. A useful paper, as emphasising the results obtained by other investigators in the same field, is contributed by Mr. Caleb A. Fuller on "Oysters and Sewage in Narragansett Bay." The author found that oysters from a bed two miles below the sewer outlet contained bacteria typical of sewage, that 30 per cent. of the oysters from a bed situated in a strong tidal current about five miles from the sewer contained *B. coli*, that 40 per cent. of the oysters from a bed in sluggish water five-and-a-quarter miles from the sewer contained *B. coli*, and that these objectionable bacilli were only absent from oysters in beds situated more than six miles from the sewer outfall. Dr. W. J. Class submits another claimant to the title of the scarlatina microbe, in the shape of a

diplococcus said to be invariably present in cases of scarlatina and found in the throat secretions, blood, scales and urine of persons suffering from scarlet fever. He has spent much labour and time in endeavouring to place the title of this *Diplococcus scarlatinae* beyond dispute. The papers submitted, judging by the abstracts supplied by Prof. Conn, were of a high order, and the existence of such a society suggests that bacteriology in this country might well be accorded a more important place amongst the sciences than it at present occupies.

THE ninth edition of Mr. Bennett H. Brough's deservedly successful "Treatise on Mine-Surveying" has been published by Messrs. C. Griffin and Co. The book has been carefully revised, and new devices and appliances of importance are described. "The chief additions," we read, "consist of notices of the use of a spring balance for maintaining steel bands at a constant tension, of Mr. Langer's method of surveying with the hanging compass in the presence of iron, of Mr. Troye's method of marking underground stations, and of Mr. Landis's method of determining the volume excavated in open workings." By keeping his book up to date in this way, Mr. Brough makes his manual most valuable to mining students and mine-agents, who regard it as an essential volume for their libraries.

THE additions to the Zoological Society's Gardens during the past week include a Brown-headed Stork-billed Kingfisher (*Pelargopsis gurial*), an Eastern Calandra Lark (*Melanocorypha bimaculata*), an Eastern Linnet (*Acanthis fringillirostris*), a Glossy Calornis (*Calornis chalybeius*), a Small-billed Mountain Thrush (*Oreocincla dauma*), a Large Pied Wagtail (*Motacilla maderaspatensis*), an Ashy Wood Swallow (*Artamus fuscus*), a Bay-backed Shrike (*Lanius vittatus*), an Indian Great Reed Warbler (*Acrocephalus stentoreus*) from British India, a Pale Rose-finch (*Rhodospiza obsoleta*) from Afghanistan, presented by Mr. E. W. Harper; three Changeable Lizards (*Calotes versicolor*) from India, presented by Mr. R. C. McLaren; four Two-banded Monitors (*Varanus salvator*) from the East Indies, a Stump-tailed Lizard (*Trachydosaurus rugosus*) from Australia, four Changeable Lizards (*Calotes versicolor*) from India, twenty-four Black-spotted Lizards (*Algiroides nigro-punctatus*) from the Borders of the Adriatic, deposited; a Tasmanian Wolf (*Thylacinus cynocephalus*) from Tasmania, purchased; two Barbary Wild Sheep (*Ovis tragelaphus*) born in the Gardens.

OUR ASTRONOMICAL COLUMN.

DISTORTION OF SUN'S DISC AT HORIZON.—Prof. W. Prinz, of the Royal Observatory of Belgium (Brussels), has obtained several large-scale photographs of the setting sun, which show most distinctly the considerable deformation of the disc when near the horizon. The instrument employed was a photoheliograph by Steinheil. A reproduction of one of the photographs accompanies the note in *Mem. della Soc. degli Spettroscopisti Italiani*, vol. xxxi. pp. 36–39. In this case the ratio of the vertical diameter to the horizontal one is as $75:84 = 0{\cdot}893$.

THE CROONIAN LECTURE.[1]

A PECULIAR interest—the parallel of that which in the plant organism belongs to chlorophyll—attaches to hæmoglobin, for, unlike any other chemical component of the animal body, in virtue of its special chemical and physical attributes, this remarkable substance may in the strictest sense be said to possess a definite and unique physiological function.

The region of the solar spectrum which the author formerly investigated was that comprised between the lines F and Q (4861—3280). The question whether oxy-hæmoglobin presents definite absorption for light of shorter wave-lengths has since been examined. Soret, whose observations were not conducted with solutions of hæmoglobin, but merely with diluted blood, observing by the aid of his fluorescent eye-piece the cadmium spark spectrum, found that diluted blood, in addition to the absorption band in the extreme violet, exhibited two additional bands. One of these, coinciding with the 12th cadmium line (3247), he considered to be probably due to hæmoglobin; the other, coinciding with the 17th cadmium line (2743), he assumed to be caused by serum albumin, his observations having previously shown that all albuminous and albuminoid bodies, with the exception of gelatin, are characterised by an absorption band in the position of the 17th cadmium line.

Employing solutions of many times crystallised oxy-hæmoglobin of great purity and of varying concentration, and with the aid of the sparks of a powerful induction coil, the author has obtained a series of photographs of the cadmium spark spectrum with and without the interposition of the solutions. The examination of these photographs shows that solutions of oxy-hæmoglobin which are sufficiently transparent to allow the ultra-violet spectrum of cadmium to be photographed present no absorption bands corresponding either to the 14th or the 17th cadmium lines. The absorption band observed by Soret in correspondence with line 14 is, therefore, not due to the blood colouring matter, but to some other organic constituent present in the blood.

Having referred to his researches communicated to the Royal Society in June 1901, and illustrated the main facts by actual demonstrations, the author discussed (1) observations on the influence of temperature on the behaviour of oxy-hæmoglobin in the magnetic field; (2) observations on the ferro-magnetism of the ferro-albuminates.

He next dealt with the question of the specific conductivity of solutions of pure oxy-hæmoglobin. After a laborious investigation on this branch of the subject, the following conclusions were arrived at:—

(1) Although solutions of oxy-hæmoglobin possess a low conductivity, this is very much higher than has been found in the previous observations of Stewart, all of which were made at 5° C.

(2) The conductivity of solutions of oxy-hæmoglobin increases rapidly with increase of temperature, and undergoes remarkable and permanent changes when the solution is kept for even short periods at any temperature above 0° C.

These results explain the impossibility of obtaining data which can be considered trustworthy concerning the *absolute specific resistance* of solutions of oxy-hæmoglobin.

Continuing the researches contained in his first communication to the Royal Society on the results of the electrolysis of oxy-hæmoglobin, the author has found that when pure solutions of oxy-hæmoglobin are subjected to electrolysis, there occurs a separation of oxy-hæmoglobin in a colloidal, but perfectly soluble form. He has worked with currents of from 12 to 24 volts, and the intensity of the electrolysing current measured by a milliampere-meter placed in the circuit has varied in different experiments between 0·1 and 3·0 milliamperes.

By employing an electrolytic cell in which the anode is separated from the kathode by an animal membrane (sheep's intestine or pig's bladder), it is seen that the first action of the current is to cause a separation of colloidal hæmoglobin in the anode cell. This colloidal hæmoglobin falls as a beautiful red cloud, leaving a perfectly colourless, supernatant liquid. On stirring it instantly dissolves.

The further action of the current is to cause a rapid and entire transfer of the colloidal hæmoglobin from the anode to the kathode cell. With an electrolytic cell, of which each compartment had a width of 5 mm. and contained 2·5 c.c. of a 1 per cent. solution of O_2Hb, complete precipitation and transfer occurs within 60 minutes.

On reversing the direction of the current by means of a communicator, the hæmoglobin returns again in the direction of the positive current into the original cell from which it started.

The author adduced evidence which proves that the precipitated colloidal, but yet perfectly soluble, hæmoglobin represents the undecomposed molecule of the blood-colouring matter.

The probable nature of the process which occurs under the influence of the current was discussed, as well as the character o.

[1] "On Certain Chemical and Physical Properties of Hæmoglobin." By Dr. Arthur Gamgee, F.R.S., Professor Emeritus of Physiology in the Owens College. Read before the Royal Society on March 13.

the process which leads to the transfer of the hæmoglobin in the direction of the positive current. This process is considered to be of the same nature as the phenomena studied by Quincke under the name of electro-endosmose.

Special attention was directed to the importance of the facts which the author has elicited in reference to the colloidal yet soluble form of oxy-hæmoglobin. It was pointed out that all which has been said with regard to oxy-hæmoglobin applies to CO-hæmoglobin.

A typical colloid in the sense of its absolute indiffusibility through animal membranes and parchment paper, oxy-hæmoglobin differs, however, from most colloids in the facility with which it crystallises. Hitherto it has been known in its crystalline condition and in solution in water. Now in its third or colloidal form the analogy with such a colloid as silicic acid is rendered complete.

The discovery of this form of hæmoglobin enables a conception to be formed of the state in which the blood colouring matter is probably contained in the blood corpuscles. It was known that the amount of hæmoglobin contained in the corpuscles is so large that in most animals at least the whole of the water of the blood would not be sufficient to dissolve it. It was perfectly obvious, therefore, that it did not exist in the corpuscles in a state of solution, and the opinion has generally been held that these contained some unknown compound of oxy-hæmoglobin with a constituent of the stroma. It seems highly probable that in the red blood corpuscle hæmoglobin may be merely present in its colloidal form.

Finally it was pointed out that the remarkable facility with which the new colloidal form of hæmoglobin traverses such permeable membranes as the animal membranes and even parchment paper, when its solutions are subjected to electrolysis, suggests to physiologists the possibility that certain of the phenomena of absorption in the animal body may be closely connected with electromotive changes in the tissues concerned.

QUANTITATIVE INVESTIGATIONS OF BIOLOGICAL PROBLEMS.

THE first part of the new publication, *Biometrika*, was noticed in these columns on December 5, 1901 (vol. lxv. p. 106). The second part, which we have now received, bears out the promise of its founders and shows that the new quantitative methods of investigating biological problems have every claim to rank as legitimate weapons of research. The present part contains five original communications and a number of miscellanea. Dr. Warren's paper on "Variation and Inheritance in the Parthenogenetic Generations of the Aphis *Hyalopterus trirhodus*" shows that variation within the family is 60 per cent. of the racial variation, that the offspring have no greater resemblance to the mother than in sexual reproduction, but that there may be a somewhat greater fraternal resemblance than among the offspring of sexual reproduction. Mr. W. P. Elderton, in a paper entitled "Tables for Testing the Goodness of Fit of Theory to Observation," provides a set of tables useful alike to physicists, biometricians and statisticians generally who want to ascertain rapidly whether the distribution of observed data, within the limits of "a sample," is in agreement with a proposed theory. Mr. Oswald Latter, as the result of measuring 243 eggs of cuckoos and comparing them with the eggs of the clutches in which they were deposited, has come to the conclusion that there is colour-matching in 50 per cent. of cases, and in certain of the remaining cases size-matching. The bearing of these results upon Prof. Newton's theory is considered, and that theory is shown to receive confirmation therefrom. The next paper, by Dr. W. R. Macdonell, has great practical interest in connection with criminal anthropology. The author has studied the index characters hitherto used in the identification of criminals, and now shows that there is a high degree of correlation between the organs selected. He indicates the best method of dealing with the measurements, and gives suggestions for calculating uncorrelated characters "which would furnish an ideal system of identification." In connection with that most important topic, the laws of inheritance in hybrids, Prof. W. F. R. Weldon gives an account of Mendel's results of crossing races of peas which differed in one or more of seven characters. To quote the abstract of this paper:—"From a study of the work of other observers, and from examination of the 'telephone' group of hybrids, the conclusion is drawn that Mendel's results do not justify any general statement concerning inheritance in cross-bred peas. A few striking cases of other cross-bred plants and animals are quoted to show that the results of crossing cannot, as Mendel and his followers suggest, be predicted from a knowledge of the characters of the two parents crossed without knowledge of the more remote ancestry."

The notes published under the miscellanea comprise one from Prof. C. B. Davenport in which he shows that in an "abnormal" species of Hydromedusæ, *Pseudoclytia pentata*, it appears that the less typical an individual the less its fertility, and irregular individuals are more sterile than those having some sort of symmetry. The typical form and symmetry thus tend to by preserved. Prof. Karl Pearson, from a comparison of the eggs of English and American house-sparrows, is enabled to warn biometricians "against drawing conclusions from types based on the 'modes' exhibited by small samples of living forms." In another note he also shows from mummy statistics furnished by Prof. Flinders Petrie that there has been a great increase in the expectation of life since the 2000 years which have elapsed from the Romano-Egyptian epoch. Out of 100 modern English alive at ten years of age, thirty-nine survive to be sixty-eight, while not nine survived out of 100 Romano-Egyptians. Prof. Pearson also contributes a note "On the Modal Value of an Organ of Character." Miss Agnes Fry writes on variation in leaves of mulberry trees, and gives illustrations of the leaves of eight trees of different ages. From this summary of its contents it will thus be seen that the new publication is fully entitled to that support which we urged in our notice of the first part.

THE KOZLOFF EXPEDITION TO TIBET.

THE last number of the *Izvestia* of the Russian Geographical Society (1901, iv.) contains a series of very interesting letters of Captain Kozloff, the head of the last Tibet expedition. They cover the most important part of his journey, from May 1900 to October 1901, during which Kozloff and his companions, Kaznakoff and Ladyghin, explored a quite unknown country, situated between the 36th and 29th degrees of latitude and 97–99° E. longitude. A preliminary map, 27 miles to the inch, illustrates these letters.

The expedition left Tsaidam in May 1900, after having organised a meteorological station at the old Tsaidam fort, Barun-tsasak (36° 5′ N. lat., 97° 30′ E. long., 8700 ft. alt.). It crossed the high border ridge, Burkhan budda, which runs N.W. to S.E., separating the high plains of Tsaidam from the high plateau of eastern Tibet, and reached the twin lakes of the upper Hoang-ho, Jarin-nor and Orin-nor, or Lakes Expedition and Russian, as they were named by Prjevalsky. The border ridge consists here of two parallel chains, the passes through which attain the respective heights of 15,700 and 15,600 feet, while separate peaks rise another 500 or 600 feet above the passes. Under the name of Amne-machin, it is continued further S.E. in the same direction, the Hoang-ho running on the high plateau at the south-western foot of the border-ridge.

The intention of Kozloff was to explore Inner Tibet and, if possible, to reach Hlassa; but as soon as they entered the territory of Hlassa, their route was barred by a military force. Yielding to the demands of the authorities, the expedition abandoned its intention of penetrating further west, and went southwards, with the intention of visiting the Chamdo (or Tsamdo) monastery; but its route was again and again barred by military detachments, so that finally Kozloff turned eastwards, under the 30th degree of latitude, and wintered on the Dza-chu, a tributary of the Mekong, thirty miles north of Chamdo. Later on, in the spring, he crossed once more the high range of mountains which, running N.W. to S.E., separates the Mekong from the Blue River, and reached this last under the 30th degree of latitude. There the expedition made the necessary preparations for the return journey, which was resumed in April 1901, exploring the Amne-machin region on the left bank of the Yang-tse, and returning eventually to the upper Hoang-ho lakes.

Having thus described a wide curve in Tibet, the Kozloff expedition explored lands totally unknown, where the three great rivers—the Hoang-ho, the Yang-tse, and the Mekong—descend from the high Tibet plateau to the lower regions of China, and which represented a real puzzle in the orography of Asia. It

now appears that the three rivers flow on the surface of the 12,000 feet high Tibet plateau, and are separated—not by fan-like radiating mountain ranges, but by ranges of mountains rising some 3000 feet above the plateau and all running parallel to each other, N.W. to S.E. In its western portion, the high plateau, deprived as it is of the rains of the monsoon region, is a dreary desert, covered with shingle; but in its south-eastern portion, the character of the plateau changes entirely. A deep erosion makes of it an alpine mountain region. Wide valleys and deep gorges alternate with stony ridges; the routes and the footpaths go down to a deep level, or lead to great relative and absolute altitudes. Regions of soft and of rough climate, of rich and extremely poor vegetation, rapidly alternate. This alpine character already appears in the basin of the Blue River, but it is still more evident in the basin of the Mekong, where the valleys are still deeper and their vegetation still more varied. Forests of fir and of a tree-like Juniperus make their appearance, as also growths of birch, wild apricots, apple trees and a variety of bushes. In the thickly wooded gorges, the expedition also found the conspicuous white Tibet pheasants (*Crossoptilon thibetanum*), the green *Ithaginis Geoffroyi*, the *Tetraophasis obscurus*, *Tetrastes Sewertzowii*, several species of blackbirds and a good number of the smaller birds of the Passeres group. On a bright clear day the forests and the meadows are full of bird-life. Small colonies of monkeys stay in close proximity to the Tangute encampments.

On June 13 the expedition reached at last the two lakes Orin-nor and Jarin-nor, whence it proceeded to Tsaidam, and then once more across the Gobi, back to Kiakhta. It appeared that everything was in order at the meteorological station, where regular observations were made for a full year. As to the collections made in Tibet, they were very rich and contained no less than 120 mammals, 600 birds, more than 600 species of plants (10,000 specimens) and about 300 specimens of rocks. Latitudes and longitudes were determined in thirteen different spots. The expedition is now back at St. Petersburg. P. K.

CATALYSIS.[1]

THE idea and name of catalytic action were introduced into science by Berzelius in 1835, apropos of Mitscherlich's work on the formation of ether. Berzelius pointed out that the action of sulphuric acid in this case was analogous to the action of dilute acids on starch, to the similar action of malt extract, to the decomposition of hydrogen peroxide by metals and oxides, and to the action of platinum on combustible mixtures of gases. According to Berzelius, catalytic force appeared to consist essentially in this, "that substances by their mere presence and not by their affinity have the power to rouse latent affinities, so that compound substances undergo reaction and a greater electrochemical neutralisation occurs." Berzelius made no attempt to explain the phenomenon; on the contrary, in a subsequent discussion with Liebig, he insisted on the great danger of attempting to explain incompletely understood phenomena by hypothetical assumptions, lest experimental investigation should thereby be hindered. Berzelius' warning was not heeded, and the neglect of it is felt to the present day.

Catalytic actions may be divided into four classes:—(1) Release in supersaturated systems. (2) Catalysis in homogeneous mixtures. (3) Heterogeneous catalysis. (4) Enzyme actions.

(1) This first division includes phenomena which may be regarded as fundamentally explained. The best-known case is the crystallisation of a supersaturated solution, for example, of Glauber's salt, by the admission of a very small trace of the solid substance with respect to which the solution is supersaturated. We notice here in the first place the characteristic disproportion between the quantity of the acting substance and the quantity of substance changed by its influence. By a particle of dust far below the limit of what is ponderable, it is possible to bring an indefinitely large quantity of supercooled solution to congelation. The smallest particle which suffices is between 10^{-10} and 10^{-12} gramme. The processes are not limited to supersaturated solutions of solids; they are applicable also to solutions of gas. In these cases a trace of a gas may cause the liberation of an entirely disproportionate amount of another gas. Then again, supersaturation is not limited to the liquid state. Vapours can be supersaturated in respect to liquids and solid bodies, and even in the case of solids, cases are known where they are supersaturated in respect to liquids, that is to say that when they are in contact with a small quantity of liquid in question they are converted into liquid. Supersaturation on the part of solid bodies in respect to the solid bodies which can be produced from them are very common. On the contrary, supersaturation of a liquid in respect to another liquid has not been observed and would be difficult to obtain.

The theory of all these phenomena is known. In all cases we have the formation of a system the stability of which is not the greatest possible under the given conditions of temperature and pressure. There are, on the contrary, other more stable conditions which are characterised by the fact that in them a new phase, that is a physically different component with other properties, makes its appearance. In the case of a supersaturated solution of Glauber's salt, this is the solid salt; in supersaturated soda-water, it is carbonic acid gas. As a rule such a new phase does not appear spontaneously if the supersaturation is not too great, and the system behaves as if it were in equilibrium; but if a small quantity of the absent phase comes in contact with the metastable system, the action is set going and the new phase increases until equilibrium is reached.

If the new phase is a solid substance, the releasing action is associated with a solid nucleus of the same composition. Isomorphous substances have also the property; other solid bodies, on the other hand, are without action. There is here opened a wide field for investigation, since isomorphous substances probably act by the formation of solid solutions, and it is to be ascertained whether solid substances which are not isomorphous with the substance concerned, but are capable of forming solid solutions with it, are active. Further, there are cases where solid bodies act without being isomorphous or without forming solid solutions. Such artificial nuclei can be prepared, for example, by allowing silicic acid to deposit in presence of a crystal and then dissolving the crystal by means of a suitable solvent. This subject has not been fully investigated, but it explains many apparent contradictions that have occurred in the investigation of this difficult subject. Whilst the nuclei in cases of supersaturation in reference to a solid phase must be of a specific nature, in the case of supersaturation with gases any gas whatever will act as a nucleus. This is in consequence of the fact that every gas dissolves without limit in every other gas, that is, forms a homogeneous mixture with it.

A given liquid can be simultaneously supersaturated with respect to different phases, for example, one can easily melt together sodium acetate and sodium thiosulphate to form a liquid, from which, by the addition of a nucleus of either salt, that salt is separated, whilst the other remains dissolved.

Supposing we had such a liquid flowing through a tube at one point of which was a nucleus of acetate and at another of thiosulphate, then each nucleus would continue to grow in its own way as the liquid circulated. We have here an example of the physicochemical possibility of certain organic processes to which Berzelius alluded, such as the formation of the most different substances in the animal body from one and the same liquid, namely the blood. If we might consider the blood as a supersaturated solution in respect to all these substances, it would be intelligible that every organ could increase its substance from one and the same liquid. It would be inadmissible to suppose that we have here a general theory of animal secretion, for the consideration only applies to heterogeneous phases.

Again, there is the question as to whether a compound which does not preexist in the liquid, but can only come into existence by the action of contained substances, is capable of exhibiting supersaturation in regard to other phases in contact with it. There are phenomena of supersaturation known to us in connection with calcium sulphate, solutions of which are so dilute that the salt must be almost entirely in the form of its ions. Since there are no ions in the solid salt there must be here a chemical change. Dilute solutions of lead salts and thiosulphates likewise show a supersaturation in respect to lead sulphide, which is formed from them by complicated chemical decomposition. Finally, the "physical development" in photography affords examples of such phenomena.

Further examples of possible physiological applications can-

[1] The phenomena of catalytic action have been the chief subject of investigation by Prof. Ostwald and his pupils during the past few years. An account of the chief results so far obtained, together with a statement of his own views of the general character of catalytic phenomena, was given by Prof. Ostwald in September last to the German Naturforscher-Versammlung at Hamburg. What is here given is a slightly abridged translation of this address.—A. S.

not be given here, but it is probable that many problems of organic life may find solution by the application of such principles. If we generalise the conditions which have been described, we see that the most essential condition is the presence of a metastable system which only passes to the more stable state by its inherent forces, after the way has been opened to it. The nucleus of the other phase is not the *cause* of the reaction in the sense that Robert Mayer uses this word, because it does not supply the free energy necessary for the process, but is only the means of starting a process which goes to completion by its own forces after it has once been started. We may now be quite clear that the same thing must hold for all other cases of contact action. It is just the want of proportionality between the quantity of the catalytically acting substance and the amount of change which makes it a necessary condition that the changes produced catalytically supply the necessary energy themselves. The recognition of this is apparent with Berzelius when he says that by such a process "a greater electrochemical neutralisation" is effected. One of the most prominent investigators of catalytic enzyme actions states that endothermic actions can never take place in this way. This is quite incorrect, for since endothermic reactions take place of themselves, that is, without catalytic influence, there is no reason for supposing that they should not take place under enzyme influence. It is, indeed, true that under this influence no reactions are possible in which there is a reduction of free (but not of total) energy. In other words, no reactions are possible under the influence of catalysts that could not take place in their absence without a breach of one of the laws of energy. The same is to be said about the view that catalysts can only have a decomposing and not a synthetic action. Organic chemistry affords many examples to the contrary. It is only necessary to refer to syntheses by the catalytic influence of potassium ethylate.

(2) Catalysis in homogeneous mixtures.

We now come to the largest and theoretically most important class of contact actions. The explanation given for the first class cannot here be applied, for while the essential thing in the first class was the appearance of a new phase, this is now excluded by definition. We get the right standpoint for regarding the new problem by adhering to the condition which has just been laid down for all systems that undergo contact action:—the system must not represent a stable condition, for such a system can undergo no change without the addition of energy. How, then, do unstable systems behave when they are homogeneous? The answer is that homogeneous unstable systems cannot exist otherwise than in a state of change. The supersaturated solution can, if the supersaturation is within certain limits, be kept unaltered for an indefinitely long time, when properly protected. A liquid, however, which without the addition of free energy can produce other soluble liquid products cannot be kept without forming these products. This change may proceed, no doubt, very slowly, so slowly that without tedious investigation specially directed to the point no change at all can be observed, but the surest basis for general conclusions that we know—the laws of energetics—demand, as a matter of fact, that the change must take place. They prescribe no numerical value to the velocity; they only demand that the velocity be not strictly zero, but that it shall have a finite value.

By these considerations we gain now for this present case the definition of a catalyst.

A catalyst is any substance which alters the velocity of a chemical reaction without appearing in the final product.

In this definition we purposely avoid expressing any view as to what is the cause of such influence. We must, indeed, take care only to state that for all catalytic actions, causes of the same kind are at work. We seek at present only a definition which will be helpful towards a scientific investigation of the question.

That the definition just given fulfils this purpose will be at once recognised, for it leads directly to inquiry into the numerical value of the acceleration or retardation, and the dependence of this on the nature and concentration of the catalysts, the temperature, the presence of other substances, &c. It is evident, and it must be insisted upon, that all attempts to propound theories for the cause of catalytic phenomena will remain useless until quantitative measurements of the kind referred to have been made.

Regarding catalysis in the sense just defined, it is an extremely common phenomenon, one, as a matter of fact, that appears wherever the velocity of chemical reaction can be measured. The well-known researches of Menschutkin furnish a capital example. He proved that for a number of different kinds of reactions, the velocity varied between very considerable limits, according to the solvent. We must regard this effect of the solvent as catalytic. We do not thereby prejudice the further question as to the actual cause; whether, for example, there is combination between the solvent and the reagents, leading to an alteration of the active masses and so to alteration of the velocity.

We may bridge over the gap between influences of this kind and others in which vanishingly small quantities of an additional substance alter the velocity to a very high degree. Hitherto only the exaggerated cases have been called catalytic, but as the difference is only quantitative a division between them is not justifiable. So far the cases which have been investigated and measured are those in which great influences are exerted by small quantities of material, but restricting ourselves even to these, the number of cases is extraordinarily great. We are especially indebted to the labours of Schönbein for an almost endless list of such reactions. Schönbein certainly did not know that he was dealing only with accelerations of slow spontaneous processes; on the contrary, he looked upon them as being initiated by catalysts. We are thus confronted with the task of subjecting the raw material of this untiring and original investigator to a quantitative revision, a labour which would engage the united activities of a whole series of workers.

I will not attempt to enumerate such cases: I will only remark that there seems to be no kind of chemical reaction which cannot be catalytically influenced, and no chemical substances, whether elements or compounds, which cannot act catalytically. Likewise the answer to the question already asked by Berzelius, as to whether there are general or specific catalysts, must be that both kinds exist. Whilst, for example, the presence of hydrogen ions accelerates most chemical reactions, so that they must be regarded as catalysts of great generality, there are, especially among the enzymes, specific catalysts which only exert their accelerating action on perfectly definite substances. The other question of Berzelius, as to whether different catalysts can produce different products from the same substance or substances and whether different possible reactions in a given system can be effected in different ways by different catalysts, must, I think, be answered in the affirmative, although no special experiments have been made in this direction.

The first theory of catalytic phenomena was set up by Liebig and for the purpose of showing that Berzelius' conception was superfluous. Liebig regarded catalysis as the direct consequence of the law of inertia. His statement is as follows:—"The cause lies in the capacity which a substance undergoing decomposition or combination, that is, in chemical activity, possesses of arousing in a body in contact with it the same chemical activity, or of making the body susceptible of the same kind of change. This capacity is best illustrated by a burning substance, by means of which similar activity is aroused in other bodies when we bring the burning one in contact with them."

Liebig has obviously not been felicitous in this explanation. His example recoils upon him, for in order to ignite the substance we do not require a burning body, but a hot one, and it is a matter of indifference whether it is hot by means of chemical reaction or from any other cause, for example an electric current. Such objections as these were raised to Liebig's view, and he found himself obliged to give his hypothesis a different form. He expressed his view in reference to sugar fermentation in the following words:—"Just as heat is capable of disturbing the statical moment in the elements of many chemical compounds, so this can happen by means of a substance of which the elements are themselves in a condition of disturbed equilibrium; the motion which its atoms possess is imparted to the atoms of the elements of sugar; they cease to persist in that state in which they form sugar and arrange themselves according to their special attractions."

This hypothesis of molecular vibrations has enjoyed grea popularity, and represents even to-day the view of many people, especially of those who have not taken part in the investigations. It has the special advantage that it cannot be disproved, since it is altogether inaccessible to a test. The scientific unfruitfulness that lies in such a "theory" was the less perceived, inasmuch as the development of the rest of chemistry was taking place in a direction where the employment of molecular hypotheses had the value of a very important scientific auxiliary

When, however, we attempt to derive from it the slightest guidance towards experimental and exploratory work, or to deduce an idea of the possible laws of catalytic actions—and this is, indeed, the only purpose of such hypotheses—we are convinced of its entire fruitlessness. That the hypothesis of molecular vibrations drove the whole matter into a blind alley is obvious from the fact that steady scientific investigation of the problem, previously prosecuted with much zeal, did not follow. For quite a long time only isolated investigators concerned themselves with describing catalytic phenomena. Schönbein himself, to whose investigations we are so much indebted for what we know of the facts, took no part in the theoretical discussions as to the causes; on the contrary, it obviously gave him pleasure to investigate phenomena for which contemporary chemistry, to which he paid little heed, could find no explanation or place of refuge.

It is possible to speak much more favourably of another view which had long before been advocated, but meanwhile had been neglected. This is the idea of *intermediate reactions*. This had its origin in the first scientific investigation of the chemical processes that take place in the lead chamber in the manufacture of sulphuric acid. Clement and Desormes, in the year 1806, in a classical research gave the explanation, still generally accepted, of the action of oxides of nitrogen in the oxidation of sulphurous acid by atmospheric oxygen. As everyone knows, this rests upon the assumption that the sulphurous acid is oxidised by higher oxides of nitrogen, which are thereby reduced to nitric oxide. This then unites again with atmospheric oxygen, and the process can begin anew. Thus a very small quantity of oxides of nitrogen serves to oxidise a large quantity of sulphurous acid. It is remarkable that at the time of the discussion between Berzelius and Liebig this case was not brought forward, and only later do we find applications of this old view to other cases where similar chemical processes are brought about. Then, however, this mode of viewing the phenomenon became more and more general, and to-day we must regard it as the oldest and most important attempt to explain certain, though not all, catalytic processes. As a rule, however, there certainly exists a weakness in this view. In confronting a catalytic phenomenon, we seek for the possible intermediate product in the formation of which the catalyst could take part, and we consider the problem essentially solved when we can fix upon such. If we succeed, indeed, in getting some of the assumed intermediate products from the materials, the view is considered to be proved. Whether such a substance is truly an intermediate product, and not merely some bye-product, is a question which is hardly raised and still less answered.

If we test the idea from our present standpoint, we find at first something contradictory in it. In order that a process can occur at all, it must be associated with the diminution of free energy. This loss depends only on the initial and final stage of the reaction, not upon its course. On the other hand, the velocity of the reaction in strictly comparable cases is proportional to this loss. Hence we should be inclined to conclude that the velocity of reaction in a given system must have the same value, whether the process is direct or indirect—whether it takes place in one leap or in several steps.

Such a conclusion would be incorrect, for besides the loss of free energy, the velocity of reaction depends upon many other factors, which are by no means all known. A well-known example is the very great influence which temperature has, an influence which counts much more than the corresponding increase of free energy. Chemical energetics also teach us that while definite generalisations may be made concerning the equilibrium of a given system, this is not the case with the actual velocity with which equilibrium is attained. There is thus no contradiction of general laws, if we assume that a certain course of reaction takes place more quickly through an intermediate substance than it does directly. Nothing can be said for, but something against, the view that this is generally the case.

Coming back now to our classical example, which indeed in other respects will be historical, we can assume that sulphurous acid is oxidised more slowly by the oxygen of the air than by the two reactions. Oxidation of sulphurous acid by nitrogen peroxide and oxidation of nitric oxide by atmospheric oxygen run concurrently, although the concentration of the intermediate products must necessarily be smaller than the concentrations which act in a direct reaction. Whilst, however, we may regard this view as scientifically founded, there is still a chief thing wanted. The velocity of the reaction concerned must be actually measured, and until this is done one can only speak of a conjecture and not of an explanation, and what is said here is true in general for the assumption of an intermediate reaction. No catalytic acceleration is explained, unless it is also shown that the intermediate reactions actually take place more rapidly than the direct reactions, under the given conditions. Up to now, no case of this kind has been satisfactorily investigated, and no such explanation actually proved for a given case. I certainly hope that this gap will not long remain, as investigations directed to this point are approaching their conclusion.

If we assume that in certain cases the correctness of the theory of intermediate products is proved (which to all appearances is the case), we have the further question, whether all catalyses will find an explanation in this way. I believe this question may certainly be answered in the negative. I believe that there are a number of cases in which such an explanation is not applicable. In particular, I see no possibility of explaining the retarding catalytic influences by the assumption of intermediate products, for if a reaction goes more slowly *via* the intermediate products than in the direct path it will take the latter, and the possibility of intermediate products has no influence on the process.

Another theory of catalysis has been put forward by Euler. Starting from the assumption that all chemical reactions are reactions of ions and that the velocity depends on the concentration of active ions, he supposes that the catalytic substance has the property of altering the concentration of the ions. In accordance with this alteration in the concentration, the velocity of the reaction must also alter.

So far as I can see, such a theory is admissible, that is to say, it would usually be possible to make the assumption without contradicting the laws of general chemistry. Whether or not ultimately contradictions would appear, cannot be foreseen at present. There appears to be one difficulty in the fact, often observed, that two catalysts acting together effect a much greater acceleration than would be calculated from the sum of their separate effects. It is not obvious how, by the simultaneous action of the two catalysts (for example, Cupriion and Ferriion), so much larger quantities of reactive ions could be formed than these can form acting apart.

One may say of this theory, then, that it might explain some catalyses, but by no means all.

A more complicated case of catalytic phenomena is found in processes where one of the substances taking part in the reaction acts also in the capacity of catalyst. Among the possibilities of this *auto-catalysis*, I will only mention the case of a reaction producing an accelerator. This occurs, for example, in one of the best-known reactions, the solution of metals in nitric acid. The nitrous acid here formed increases in a high degree the velocity of reaction of the nitric acid, whence arise the following phenomena :—If the metal is brought into pure acid, the reaction begins with extreme slowness. In the same degree as it progresses, it becomes more rapid and in the end tumultuous. When this period is passed, the process slows down and ends with a velocity converging on zero.

This stands in striking contradiction to the usual course of reactions, which begin with a maximum of velocity and, owing to the gradual consumption of active substances, become constantly slower.

Physiological analogies present themselves irresistibly at this point. We have here a typical *fever* phenomenon. Another important physiological fact can be illustrated in the same way, *habit* and *memory*. I have here two specimens of the same nitric acid, differing only in this, that in one a small piece of copper has been already dissolved. I now bring two similar pieces of copper foil into the two acids, which are at the same temperature. You see that the acid which has already once dissolved the copper has become "habituated" to the work and begins instantly and vigorously to carry it out, while the other unpractised acid does not know how to begin with the copper, and sets about its work so clumsily and so slowly that we will not wait for it.

That we are here dealing with catalysis by means of nitrous acid will be obvious when I add some sodium nitrite to the dilatory acid; the copper is now at once attacked and dissolved.

(3) Heterogeneous Catalysis.

The best-known case of heterogeneous catalysis is the action of platinum on combustible mixtures of gases. Whilst previously the chief interest centred round mixtures of hydrogen and

oxygen, it has now passed for practical reasons to the combustion of sulphur dioxide to trioxide. In this case we are concerned, no doubt, with slow reactions, although it may be admitted that, for example, in the case of electrolytic gas, no formation of water is perceptible at the ordinary temperature in the absence of a catalyst. But the regularity of the alteration of the velocity with the temperature justifies us in the opinion that after all there is a very small velocity of reaction even at the ordinary temperature. The extremely small value is in accordance with the general fact that a gas reaction takes place very slowly. This important fact appears, for example, in the experiments of Berthelot and Péan de St. Gilles. The ester formation from acid and alcohol was compared in two experiments of the same kind, in one case the substances being liquid, in the other gaseous. Even if the experiment does not permit of an exact calculation as to whether the retardation may be fully explained by the great reduction of concentration, or whether, as is more probable, it goes beyond that, it is not to the point. It is sufficient to know that by transition to the state of gas, the velocity of the reaction is reduced to about 1/1000th.

It is possible now to set up a theory of the accelerations just mentioned. If we suppose that in the gaseous system, at a given temperature, one part is replaced by a liquid or acquires a density corresponding to the liquid state, then in this part the reaction will take place proportionately more quickly, and the liquid part of the materials will be converted into the final products. If then the liquefying or condensing source is of such a nature that it goes on condensing fresh quantities of materials as fast as the old are being used, these will react quickly and the result is acceleration of the reaction. That such is the case in the action of platinum on gases is quite possible. I do not wish to assert by this representation that the catalytic action takes place in such a way, but only to point out a possibility as to how it might take place. We should then have the simplest and purest case of an accelerating intermediate reaction to which I have already referred.

As Prof. Bredig has recently told me, it is possible to represent the mechanism of such an acceleration by means of a fluid medium in which small masses of another fluid are suspended. If this suspended liquid has the property that in it the reaction of the substances present can take place more quickly than in the main mass of the liquid, the portions of the reagents residing there will be the first to undergo change. The products will diffuse into the enveloping liquid, and thus new quantities of reagents will enter, since diffusion is always at work regulating the concentration. In this way the whole quantity of the reagents will successively find a way through the suspended liquid and react there, and the result is an acceleration of the reaction.

Bredig supposes that this view may be applied to the case where a catalyst is present in a colloidal state in the liquid. As is known, Prof. Bredig and his pupils in a series of remarkable investigations have demonstrated the manifold and energetic catalytic actions which are brought about by colloidal platinum and other colloidal metals prepared by him. He also pointed out that the extremely active catalysts occurring in nature, the enzymes, occur likewise in a state of colloidal solution or suspension.

These views have no other pretension than to be views which can be brought to an experimental test. I must not omit to draw attention to the fact that it is the view of catalysts as accelerators that has made it at all possible to put forward notions which can be so tested. Let anyone try to attain the same end by means of molecular vibrations.

(4) Enzymes.

Berzelius had no doubt that the conversion of starch into sugar by means of acids was to be classed with similar conversions by means of malt extract. The same view was held by Payen and Persoz, who isolated the active substance, diastase, or at least prepared it in a concentrated form. The same view holds good for Liebig and Wöhler, who in an excellent research studied the decomposition of amygdalin under the catalytic influence of emulsin.

The later investigations of the laws of enzyme action have, in my opinion, brought to light nothing which gives ground for a fundamental distinction between the two kinds of action. On the contrary, the researches of Bredig, before mentioned, have displayed a much more thorough-going correspondence than might have been expected.

We shall look upon the enzymes, therefore, as catalysts which arise in the organs during the life of the cell and by whose action it discharges the greatest part of its duties. Not only are digestion and assimilation from beginning to end regulated by enzymes, but the fundamental life activity of most organisms, that is to say, the acquisition of the necessary chemical energy by combustion in atmospheric oxygen, takes place with the definite cooperation of enzymes, and without this would be impossible, for free oxygen is known to be a very inert substance at the temperature of organisms, and without an acceleration of the reaction, the maintenance of life would be impossible.

Berzelius had already pointed to the decisive importance that attaches to enzymes in the economy of the living being. As a matter of fact, if we put the fundamental question, "what is the physicochemical criterion of the phenomena of life?" the answer will be, "an automatically regulated production and use of chemical energy, for the animation, maintenance and increase of the living thing." We have three different means of influencing the velocity of chemical reaction—temperature, concentration and catalysis. Of these three, the first cannot be obtained for the organism at its will. We see, indeed, that in the higher animals, in which especially complicated and delicate functions are to be fulfilled, there is complete freedom from the influence of temperature, inasmuch as they provide themselves with thermostatic appliances by means of which their body temperature can be maintained constant between certain limits. Concentrations are in many ways limited by the solubility of the substances concerned. There remains only one generally applicable means of regulating the velocity of the reactions—the application of catalysts—and this without doubt admits of the solution of the problem in ideal completeness.

I must not go further into the physiological question, but I did not wish to omit pointing out the importance of catalysis in this direction. This seems to me to be at the present time especially necessary. The older chemistry, with its facts and theories, which were concerned with the preparation and the systematic and genetic relations of substances, without regard to the laws of equilibrium and change, has proved in many respects unproductive in the explanation of physiological phenomena, and it seemed as if chemistry and physics were altogether unable to contribute anything decisive towards solving the riddle of life.

On the other hand, I should like to point out with all reserve that physical and general chemistry, in the domain of which the greater portion of this question lies, is a very young science. Those of you who were present at the Naturforscher Versammlung in 1892 will remember that it first, so to speak, "came out" there like a full-grown young lady. Hitherto she has found so much to do in her own house that she has only been able occasionally to pursue her labours in other regions, but it cannot be denied that many a hand has wished to pluck the fruits without knowing what to do with them.

It is my full and repeatedly expressed opinion that by means of the later advances of chemistry there lies before physiology a development which will be in no degree less important than that which was brought about by Liebig in his time by the first systematic application of chemical science.

So far as the properties of the enzymes are concerned, these have hitherto been investigated mainly in a qualitative way. Quantitative work meets with the great difficulties which lie in the alterability of the substance, associated, as a rule, with the loss of catalytic power. The enzymes hitherto investigated show essentially the chemical properties of albumenoids, but the question of their chemical nature is by no means yet settled. I should like to express my conviction that a more thorough investigation will disclose other intermediate stages between albumenoid products with which enzyme activities have been shown to be associated and the more simple compound substances of organic chemistry. Thus, for example, the catalytic acceleration of some oxidation processes which are characteristic of hæmoglobin seems to be maintained in its non-albumenoid derivatives, especially in hæmatin, and a following out of these relations in the decomposition products of the colouring matter of the blood would be of no slight interest.

In a few cases in which the cause of the velocity of an enzyme action has been studied in such a way as to be completely free from objection, contradictory results have appeared; while some authors have found a thorough-going agreement with the simple laws which are applicable to inorganic catalysts, others have found discrepancies.

From a hitherto unpublished article which lies before me, and in which I am inclined to place great confidence, I gather as a matter of fact that the time law of enzyme actions differs from the simplest scheme of reaction velocities. This question is, however, not yet ripe for discussion.

The question of the range of substances which can be altered by a given enzyme in a certain manner (for example, hydrolysed) is likewise in the first stage of solution, and there seems to be here similar multiplicity of function to what is found in the case of other catalysts.

The beautiful investigations of E. Fischer have shown that at any rate the very slight differences which nowadays we know in chemistry as stereochemical can bring about alteration in the action of a given enzyme. As to whether this rests on the asymmetric character of the enzyme itself or on other grounds appears to me not to have been decisively ascertained.

I must hasten to a conclusion. I have set myself the task of pointing out the broad provinces of a fertile land, which only here and there shows the first beginning of systematic cultivation, but of which the fruitfulness and importance is beyond all question. Even if the land lies outside the region to which the chemistry of the past was acclimatised, still our restless science has already begun with its new implements to make the new soil fruitful. That it is not only a chemical interest that makes the work grateful I think I have shown you by examples of its physiological application. It is also evident, from the examples which we already have of the application of this auxiliary, that the scientific knowledge and investigation of catalysis must have vast consequences in technical applications. The last great triumph of German technical chemistry, the synthesis of indigo, which will revolutionise the agricultural conditions of whole countries, contains as an essential factor a new catalysis. The oxidation of naphthalene by means of sulphuric acid with speed can only be brought about in the presence of mercury. The sulphuric acid itself, it is hardly necessary to say, is prepared by a catalytic process, whether we use the old or the newer method. When we consider that the acceleration of the reaction by catalysis is achieved without consumption of energy, and so proceeds in this sense *gratis*, and that in chemical industry, as in all other, time is money, we perceive that the systematic utilisation of catalytic appliances is likely to lead to the most thorough-going changes in manufacturing processes.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

THE Government Education Bill has been the subject of much discussion since Mr. Balfour described its provisions to the House of Commons last week. Public opinion is decidedly in favour of the creation of local educational authorities, but it is felt that unless these new bodies are made responsible for elementary as well as secondary education, the main object of the Bill will be lost. As the president of the National Union of Teachers pointed out at the conference at Bristol, there would still exist in the same district "separate authorities for primary and secondary education, with their useless and unnecessary administrative expenditure, their jealous rivalries and interminable friction." The only way to end this state of things is to make each constituted local authority responsible for the whole of the educational work in its district. There must be no clause making it optional to adopt the elementary part of the measure, for in many cases this would mean that there would still be competing schools and educational agencies instead of an organised system. The members of School Boards who have a real knowledge of education would naturally be absorbed by the local authorities, and those who are more identified with sectarian and political interests would be left to find another platform for their polemics. The views of teachers in primary schools are expressed in the following resolution brought before the Bristol conference by Mr. R. Waddington:—"That conference expresses approval of the main principles of the Education Bill, 1902, under which may be created local authorities controlling and maintaining all forms of education within wide areas, and hereby records its satisfaction with the Government's desire to place our educational system on a sound basis; but is of opinion that the measure cannot become educationally effective unless the permissive clauses of the Bill relating to elementary education be struck out, and it be made compulsory upon the local authorities to take over the control of elementary as well as of higher education." If the Government decide to withdraw the optional clause the measure will meet with general approval from most educationists.

PROF. R. MELDOLA, F.R.S., has been appointed by the President of the Board of Education a member of the Teachers' Registration Council, which has just been created to consider claims to be admitted to the Register of Teachers.

THE Lord Mayor of Liverpool has issued an appeal for funds to establish a Liverpool University upon the University College of the city. To effect this, about 330,000*l*. will be required, of which there has already been promised no less than 145,000*l*. by leading citizens. The present value or possessions of the College itself amount to more than 500,000*l*.; and the additional sum of 330,000*l*. which is asked for is to complete its equipment as a university. The existing resources of the College, the endowment of chairs and lectureships, amount to 186,300*l*.; the sites acquired and buildings erected and in course of erection, 251,550*l*.: fellowships, scholarships and prizes, 32,800*l*., exclusive of value of fellowships and scholarships established by annual gifts or granted by city and county councils, the Royal Institution, the Ladies' Educational Association, the Tate trustees, and other bodies outside University College; endowments for maintenance, 20,275*l*.; and day training college hostel and endowment, 10,000*l*. The total of 500,925*l*. does not include the value of books in the library and apparatus in laboratories, nor does it take account of sums, amounting to many thousands of pounds, given to the college year by year for immediate expenditure, nor of the annual income of the affiliated schools of architecture and applied art, public health and tropical medicine. The additional lectureships to be endowed include electrotechnics, geology and chemistry, besides others in connection with commerce, engineering and medicine.

SCIENTIFIC SERIAL.

American Journal of Science, March.—The ventral integument of trilobites, by C. E. Beecher. In previous studies of trilobites the author had not thought it worth while to illustrate the character of the ventral integument, but a recent discovery by Jaekel necessitates the separate consideration of this structure. From a study of a specimen of *Ptychoparia striata*, Jaekel has deduced an entire reconstruction of the appendages and anatomy of the trilobite. An examination of well-preserved specimens of Triarthrus, several photographic reproductions of which accompany the paper, leads to the conclusion that the deductions of Jaekel are erroneous.—Igneous rocks from eastern Siberia, by Henry S. Washington. The specimens examined included a foyaite from East Cape, comendite, quartz-porphyry, rhyolite, obsidian and monzonite from Iskagan Bay.—A cosmic cycle, by Frank W. Very.—Studies of Eocene mammalia in the Marsh collection, Peabody Museum, by J. L. Wortman. The present instalment is devoted to a consideration of *Limnocyon verus*, *velox*, *medius* and *dysodus*.—An experimental method in the flow of solids and its application to the compression of a cube of plastic material, by J. R. Benton. Frames of parallel wires were cast into the centre of a cube of Wood's metal. After the cube had been distorted beyond the elastic limits in a testing machine, the fusible metal was melted off and the structure of the framework examined. The condition of the wires after varying treatment is shown in a series of diagrams.—On the occurrence of monazite in iron ore and in graphite, by O. A. Derby.—The molecular weights of some carbon compounds in concentrated solutions with carbon compounds as solvents, by C. L. Speyers.—Clarence King, by S. F. Emmons. An account of the life-work of the late Clarence King.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, March 6.—"Experimental Researches on Drawn Steel.—Part i. Magnetism and its Changes with Temperature.—Part ii. Resistivity, Elasticity and Density, and the Temperature Coefficients of Resistivity and Elasticity." By J. Reginald Ashworth. Communicated by Prof. Schuster, F.R.S.

When magnets are heated and cooled and the cyclic state is reached, the relation of intensity to temperature is expressed by the equation

$$I_t = I_0 (1 + a t),$$

and the coefficient, a, almost universally is negative. But if a magnet be constructed of pianoforte steel wire, of large enough dimension ratio, then the coefficient is positive and the magnet gains in magnetism as the temperature rises. An attempt to trace the cause of this abnormal behaviour of pianoforte steel has led to a complete experimental investigation of the temperature coefficient of a magnet. Experiments on this wire when in the commercial drawn state, in the annealed condition, and when glass hard showed that it was only in the first state that an incremental coefficient exhibited itself, and it thus appeared that the drawing was responsible for the abnormal behaviour of the pianoforte wire. Samples of such wire were then obtained representing every stage in the manufacture from the rolled rod through annealing and tempering to the utmost stage of drawing, and from experiments on them it was demonstrated that the positive coefficient was developed by moderate drawing, but that extreme drawing tended to reduce it to zero.

The intensity of residual magnetism is remarkably increased by drawing, so that at last it is 200 per cent. greater than at first.

The relation of the curves of magnetisation of a very long thin wire of drawn steel, when cold and when hot, was next traced, and is highly interesting, as the susceptibility hot is always greater than the susceptibility cold even at maximum intensity, and it is not until the demagnetising force has been applied that the curves intersect; with iron and ordinary steel, the intersection of the curves is always on the ascending path. The temperature coefficient of induced and residual magnetism was examined at a number of points on the upward and downward curve for both drawn steel and iron, and it appears that the incremental coefficient in the drawn steel is largest, and the decremental coefficient in iron is least, when the susceptibility is a maximum, and in general the coefficient varies with the susceptibility. Another interesting observation is that after partial demagnetisation, heating and cooling restore some of the lost magnetism, and even when the whole of the magnetism is removed and an inverse magnetism of small intensity is impressed by the reversed force, heating and cooling clear this out and restore some of the original magnetism. The bearing of these experiments on the construction of magnets of constant intensity is pointed out. Observations extending over several years are given on four magnets of drawn steel.

In part ii. the relation of drawing to resistivity, to Young's modulus, and to density is traced. Resistivity is diminished by moderate drawing, but extreme traction again increases it; the temperature coefficient of resistivity is affected inversely to the resistivity. Young's modulus increases with moderate drawing and sharply declines with extreme traction; its temperature coefficient behaves inversely, so that when the modulus is large the coefficient is small, and conversely.

Density increases throughout with traction to the last stage and is then 8 grams per cubic centimetre. Magnetic intensity and density seem to be closely related, varying proportionally over a considerable range, so that the ratio of magnetic moment to the mass approaches a constant.

Chemical Society, March 19.—Prof. Emerson Reynolds, V.P.R.S., in the chair.—Nitrogen chlorides containing the propionyl group, by Dr. Chattaway. A description of chloro-derivatives of propionanilide obtained by the interaction of hypochlorous acid with propionyl derivatives of aniline.—The constitution of the metallic cyanides as deduced from their synthetic interactions. The constitution of hydrogen cyanide, by Mr. J. Wade. The formation of both organic nitriles and isonitriles by the interaction of alkyl halides with metallic cyanides seems to imply that the latter may in some cases have either of the constitutions R.C⁝N and R.N:C. The author adopts an extended form of Nef's explanation for this reaction, which assumes that the metallic cyanides are really isocyanides, and that the formation of nitriles on interaction with alkyl halides only occurs where the metal is highly positive and its isocyanide capable of forming an intermediate addition compound with the alkyl halide.—The absorption spectra of metallic nitrates, i., by Prof. Hartley, F.R.S. The author has investigated the absorption spectra of various nitrates in dilute aqueous solution. A full discussion of the results will be given in a later paper.—A method of determining the ratio of distribution of a base between two acids, by Messrs Dawson and Grant. An aqueous solution of the base and the acids is shaken with an unmiscible solvent capable of extracting one of the four possible substances present in the mixture. From the amount so removed the concentration of that substance in the solution can be determined and indirectly the amount in combination.—The molecular complexity of acetic acid in chloroform solution, by Mr. H. M. Dawson. A study of the way in which acetic acid distributes itself between chloroform and water with increasing dilution leads the author to believe that a gradual dissociation of the double molecules occurs with dilution.—The existence of polyiodides in nitrobenzene solution, by Messrs. Dawson and Gawler. In studying the ratio of distribution of iodine between the two solvents nitrobenzene and aqueous solution of potassium iodine, it was found that nitrobenzene containing iodine dissolves considerable amounts of potassium iodide due to the formation of polyiodides of potassium.—Derivatives of α-aminocamphoroxime, by Dr. Lapworth and Mr. Harvey. A description of salts and other derivatives of this oxime.—Preparation of sulphamide from ammonium amidosulphite, by Prof. Divers, F.R.S., and Mr. Ogawa. When ammonium amidosulphite is slowly heated to about 70° C., it yields about 10 per cent. of sulphamide.—Hypoiodous acid, by Mr. R. L. Taylor. The author finds that the amount of hypoiodous acid formed by the interaction of iodine and mercuric oxide depends to some extent on the fineness of division of the iodine, *precipitated* iodine furnishing 44 to 52 per cent. of the possible yield, whilst *powdered* iodine gives only small amounts.—Synthesis of imino-ethers, by Dr. G. D. Lander. A description of N-aryl benzimino-ethers produced by the interaction of aromatic imide chlorides and sodium alcoholates.—Nitration of *sym.*trihalogenacetanilides, by Dr. Orton. A description of substances obtained by the action of nitric acid on *sym.*tribromacetanilide and chlordibromacetanilide.—Purpurogallin, by Messrs. A. G. Perkin and A. B. Steven. A description of various derivatives and decomposition products of this substance, obtained in oxidising pyrogallol.—Quercetazetin, by Mr. A. G. Perkin. The flowers of the African marigold *Tageteo patula* contain a crystalline yellow colouring-matter of the formula $C_{27}H_{22}O_{13}$, to which the above name was given by Latour and Magnier de la Source in 1877. Its composition is now found to be better represented by the simpler formula $C_{15}H_{10}O_8$; it furnishes like pyrone derivatives a sulphate and a potassium compound, and when fused with potash yields protocatechuic acid and an unidentified phenol.

MANCHESTER.

Literary and Philosophical Society, March 18.—Mr. Charles Bailey, president, in the chair.—Mr. J. E. King read the second and concluding part of his paper on the folk-lore of the North American Indians, from the Jesuit relations (1611 to 1637). This described funeral rites. The bodies of the dead, he said, were first buried in village cemeteries, but after eight or ten years a great "Feast of the Dead" was held, and the bones were reburied in a grave common to many villages. After the second burial, the soul went away to the village of the dead in the west. As with other savages, the burial ceremonies implied two feelings, namely, fear of the ghost and desire to maintain a bond of union with the kindred dead. Burial and cremation were said to imply different ideas as to the future of the soul after death, but this was not illustrated by Indian beliefs, for the Indians buried their dead and also believed in their continued existence in another world. They also held the doctrine of metempsychosis, as was shown in the practice of resuscitating dead chiefs by passing on their names to living representatives. The Canadian Indians had a special form of burial for children who died in infancy; so had the ancient Romans, and so had the Hindus, West Africans, and other tribes and nations. The Hindus and Maoris, however, regarded the spirit of an infant with dread. The Canadians and other nations looked upon such spirits as helpless and pitiable, and the mode of burial adopted indicated a belief in rebirth. The paper concluded with a quotation from Lescarbots, written in 1612, which anticipated the doctrine of survival in culture.—Mr. R. F. Gwyther read a paper on the conditions which determine the rate of propagation of an earth tremor.

PARIS.

Academy of Sciences, March 24.—M. Bouquet de la Grye in the chair.—On a non-suppurative form of osteomyelitis, by M. Lannelongue. Although acute osteomyelitis is ordinarily accompanied by the staphylococcus discovered by Pasteur in certain rare forms of the disease, the symptoms of which are

given in detail, this staphylococcus is always accompanied by other micro-organisms, in one case a streptococcus, in another a *Bacterium coli*, and in another a short bacillus as yet undetermined.—Remarks relating to the demonstration of the therapeutic properties of the methylarsenate of soda, by M. Armand Gautier. Remarks on a communication on this subject by M. Mouneyrat.—The extension of Lagrange's theorem to viscous liquids and the conditions at the limits, by M. P. Duhem. The theorem of Lagrange, extended to viscous liquids, is incompatible with the conditions that liquids ought to verify along solid walls.—The direct hydrogenation of the oxides of carbon in presence of various finely divided metals, by MM. Paul Sabatier and J. B. Senderens. If in the reaction between nickel, carbon monoxide and hydrogen the temperature is raised much above 250° C., a certain proportion of carbon dioxide is always found among the products, which at 380° C. may amount to as much as 10 per cent. of the whole. The effect of replacing nickel by other metals was then examined. With cobalt the reaction proceeds exactly as with nickel, without any secondary reactions. Neither platinum, palladium, iron, nor copper gives rise to any methane under similar conditions. —On a theorem of Frobenius, by M. de Séguier.—On commutative homogeneous linear differential expressions, by M. George Wallenburg.—Oscillations peculiar to a network of conductors in electrical distribution, by M. J. B. Pomey.—On forces which act on a cathode flux placed in a magnetic field, by M. H. Pellat.—Hertzian waves in storms, by M. Firmin Larroque. In examining the effect of very distant storms, it was found that the suppression of the horizontal plate in the apparatus rendered the system inert, but that the suppression of the vertical portion of the apparatus had no effect upon the sensibility of the apparatus. The electrical oscillations are therefore horizontal. If the storm was not so distant, less than 300 kilometres, the inverse effect was generally observed.—Contribution to the study of sounding pipes, by M. C. Maltézos.—The specific heat of bodies at the absolute zero, by M. Ponsot. The author deduces by thermodynamical reasoning that at the absolute zero two systems of solid bodies comprising the same elements have the same specific heat, and discusses several particular cases.—On the boiling-point of selenium and on some other pyrometric constants, by M. Daniel Berthelot. The measurements were carried out by the interference method previously described, the necessary uniformity in heating being achieved by the use of an electrically heated nickel spiral. The boiling-point of selenium was found to be 690° C., or 25° higher than that hitherto admitted.—On the thermal equivalent of dissociation and of vaporisation, and on the heat of solidification of ammonia, by M. de Forcrand.—On a monosodium acid orthophosphate, by M. H. Giran. It has been supposed from the experiments of Zettnow that the crystals which cover the sticks of commercial metaphosphoric acid were a variety of orthophosphoric acid. It is now shown that these crystals consist of a sodium salt of the composition $NaH_5(PO_4)_2$.—On sesquisodium phosphate, by M. J. B. Senderens. The sodium phosphate described as new by M. Joulie in a recent paper in the *Comptes rendus* was discovered in 1882 by MM. Filhol and Senderens.—The action of the halogen ethers on the sulphocarbonic compounds of secondary amines, by M. Marcel Delépine.—On some new compounds of methylene, by M. Marcel Descudé. In presence of zinc chloride, trioxymethylene condenses readily with acid chlorides, the products being obtained of the types $R.COO.CH_2Cl$ and $(R.CO.O)_2CH_2$. A list of new compounds prepared by this reaction is appended.—Cane sugar in the food reserves of phanerogams, by M. Em. Bourquelot. —On the digestion of the mannane of the tubercles of orchids, by M. H. Hérissey. The mannane of the tubercles of orchids can, like the albumens, be transformed into mannose by the action of soluble ferments present in the plant.—The action of sulphurous acid as an antidote against *la casse* in wines, by M. J. Laborde. It has been shown that the destructive action of the oxydase on the red colouring matter in wine, the disease known as *la casse*, can be prevented by the addition of sulphurous acid. It is here shown that the contact of sulphurous acid and the oxydase alone is not sufficient to destroy the oxydase, and that it is the oxygen of the air which appears to be the principal agent of destruction in this case.—On the geological section of the *massif* of the Simplon, by M. Maurice Lugeon.—On the fragments of pumice found on the ocean floor, by M. J. Thoulet.—On radiometry and its application to pelvimetry, by M. Th. Guilloz.

DIARY OF SOCIETIES.

THURSDAY, APRIL 3.

RÖNTGEN SOCIETY, at 8.30.—X-Ray Diagnosis of Renal Calculus: Dr. Ch. Leonard.

LINNEAN SOCIETY, at 8.—On the Composite Flora of Africa: W. Spencer Moore.—A Halonial Branch of *Lepidophloios fuliginosus*: Prof. F. E. Weiss.

FRIDAY, APRIL 4.

INSTITUTION OF CIVIL ENGINEERS, at 8.—Compressed-Air and its Applications: L. G. Crawford.

GEOLOGISTS' ASSOCIATION, at 8.—Klondike, its Geology and Mining: Prof. H. A. Miers, F.R.S.

MONDAY, APRIL 7.

SOCIETY OF CHEMICAL INDUSTRY, at 8.—Some Recent Improvements in the Photography of Colour: E. Sanger Shepherd.

VICTORIA INSTITUTE, at 4.30.—Locusts and Grasshoppers: Rev. F. A. Walker.

TUESDAY, APRIL 8.

ROYAL INSTITUTION, at 3.—Recent Methods and Results in Biologica Inquiry: Dr. Allan Macfadyen.

INSTITUTION OF CIVIL ENGINEERS, at 8.—*Papers to be further discussed*: The Greenwich Footway-Tunnel: W. C. Copperthwaite.—Subaqueous Tunnelling through the Thames Gravel, Baker Street and Waterloo Railway: A. H. Haigh.

SOCIETY OF ARTS, at 8.—Street Architecture: Prof. Beresford Pite.

WEDNESDAY. APRIL 9.

SOCIETY OF ARTS, at 8.—Ceuta and Gibraltar: Major-General John F. Crease.

THURSDAY, APRIL 10.

MATHEMATICAL SOCIETY, at 5.30.—A Note on Divergent Series: Dr. Hobson, F.R.S.—Stress and Strain in Two-dimensional Elastic Systems: Prof Love, F.R.S.

INSTITUTION OF ELECTRICAL ENGINEERS, at 8.—Problems of Electric Railways: J. Swinburne and W. R. Cooper.

ROYAL INSTITUTION, at 3.—The Oxygen Group of Elements: Prof. Dewar, F.R.S.

FRIDAY, APRIL 11.

PHYSICAL SOCIETY, at 5.—An Apparatus for Vapour-pressure Measurements: Mr. Grant.—(1) The use of Cathode Rays for Alternating-Current Measurements; (2) An Experiment on the Current Growth in an Inductive Circuit: Mr. Morris.—An Electric Heater: Dr. R. A. Lehfeldt.—Note on the Compound Pendulum: S. A. F. White.

ROYAL ASTRONOMICAL SOCIETY, at 5.

MALACOLOGICAL SOCIETY, at 8.

ROYAL INSTITUTION, at 9.—Problems of the Atmosphere: Prof. Dewar, F.R.S.

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THURSDAY, APRIL 10, 1902.

SENSE ORGANS IN THE VEGETABLE KINGDOM.

Sinnesorgane in Pflanzenreich zur Perception mechanischer Reize. Von Dr. G. Haberlandt, o.ö. Professor an der Universität Graz. Pp. viii + 163; 6 plates. (Leipzig: Engelmann, 1901.) Price 9*s*. net.

MR. HUXLEY has truly said[1] that "perhaps the most remarkable service to the philosophy of biology rendered by Mr. Darwin is the reconciliation of teleology and morphology, and the explanation of the facts of both, which his views offer." Prof. Haberlandt is a devoted adherent to the school of evolutionary teleology; one of his earliest publications (in 1877) was a study of the protective adaptations of seedlings, and the desire to understand the meaning of every detail of plant-structure is still the key to his activity. It has led him, following the footsteps of Schwendener, to specialise in what he names physiological anatomy, which might with equal propriety be termed teleological or adaptive anatomy. Haberlandt's book,[2] in which he elucidates the minuter structure of plants from this point of view, is a recognised classic and is found in every botanical library in the world. The present work will, we think, only add to his reputation as an investigator.

The title of his book, "Sense Organs in the Vegetable Kingdom," &c., would by itself suggest the school of thought to which Haberlandt belongs, and on his first page he asserts that the plants have specific forms of irritability which are completely analogous to the senses of animals. This school, which puts side by side the reflex movements of plants and animals, dates (in its modern development) from the writings of Pfeffer and Sachs in Germany, and from the publication of "The Power of Movement in Plants" in this country,[3] and is now generally accepted.

Haberlandt's book deals with the reflexes called forth by tactile stimulation, more especially with one branch of the subject, namely, the mechanism which localises and intensifies the touch. The means by which the disturbance, thus originated, is transmitted to the motor organs is for the moment of secondary importance with the author.

Haberlandt begins with the following definition:—

"Sense organs, or organs of perception, are those structural contrivances which contribute to the reception of an external stimulus, and show a more or less striking correspondence between structure and function."

According to this broad definition, the sense organ need not itself possess the quality of percipience. The essential characteristic is an arrangement for a sudden "deformation" of the ectoplasm in sense-cells. But certain plant-hairs and bristles are called sense organs, although they merely act like the vibrissæ of animals, that is to say like levers, the act of percipience occurring in the sensitive tissues in which they are imbedded. Haberlandt practically narrows his definition by applying the term *Stimulator* to the purely mechanical parts of sense organs, a terminology which seems to us of rather doubtful value, more especially as stimulators seem to graduate into sense organs in the narrower sense.

The simplest class of sense organs contains what the author calls *Fühlpapillen* or *Tactile-papillae.* These, as they occur in the stamens of Opuntia, &c., have been already described by Haberlandt in his "Physiologische Pflanzenanatomie"; the present book demonstrates the remarkable fact that tactile papillæ occur in many different organs and in widely distinct natural orders—a state of things with which we are familiar in many adaptive structures, and which never fails to interest us. The tactile papilla in Opuntia consists of a small conical projection from an epidermic cell, into which runs a promontory of protoplasm. The fact that the papilla projects above the general surface renders it liable to be touched by the visiting insects, and the thin walls of the apical half of the papilla allow deformation to result from contact. The papillæ in this instance are not, however, very sensitive to simple contact, for if the stamens are gently rubbed they curve but slightly, whereas if the filament is forcibly bent at the same time, as would be the case when an insect visited the flower, the reaction is greater. This is only one instance of the care with which Haberlandt has, throughout, distinguished the reaction due to contact that is produced by bending of the whole organ. In this case, and also in Portulaca, it seems that if the filament is merely stroked the needle slips over the papillæ without seriously affecting them, but pressure at right angles to the filament deforms the wall of the tactile papilla and also bends the filament.

In the filaments of Berberis, the tactile papilla is of still simpler structure, being formed by the convex projection of the whole outer wall of an epidermic cell. The distribution of the cells corresponds with that of the region sensitive to contact, and here in contrast to Opuntia a slight touch, which produces no bending of the filament, is sufficient to call forth the reaction. It is true that forcible bending of the filament also has an effect, but the movement produced is incomplete; it is interesting that the motor machinery should respond less to direct deformation of its own constituent cells than to a minute change of form in the cells specialised as sense organs.

The tactile cells in Berberis differ from the non-sensitive ones in being richer in protoplasm, in containing orange chromoplasts and starch grains. The exposed projecting wall of the sense cells is not thin as in Opuntia or Portulaca; the disturbance produced by contact is apparently due to a curious thinning away of the outer wall where it meets the radial walls. This hinge-like mechanism must allow a localised deformation of the ectoplasm to occur; the cell is, in fact, like a box with strong but loosely fitting hinged lid, the hinges being the region where deformation especially occurs. The same type—a bulging epidermic cell with a hinged connection to the radial walls—occurs in Abutilon in a different natural order. The irritable stamens of Helianthemum are worthy of notice, from the absence of all definite sense organs. Haberlandt assumes that the delicacy of the epidermis renders superfluous any special arrangements; and he compares the filaments to those tendrils in which histological adaptations are absent.

[1] "Life and Letters of Charles Darwin," ii. p. 201.
[2] "Physiologische Pflanzenanatomie." 1st Edit. 1884, 2nd Edit. 1896. (Leipzig: Engelmann.)
[3] The earliest popular statement of this point of view was published by the writer of this notice in NATURE, 1878, vol. xvii. pp. 390, 411, &c.

Simple tactile papillæ occur in stigma lobes of *Goldfussia anisophylla*; they are not highly sensitive, and a pressure on them sufficient to bend the lobe is required, but whether or no the deformation of the motile tissue acts as an accessory stimulus is not easily decided. In his section on irritable styles and stigmas, Haberlandt describes the curious movements of the style of Arctotis (Compositæ), which was discovered by D. Müller in 1853, but has, until recently, received too little attention. Like the filaments of Helianthemum, it has no special sense organs, and Haberlandt suspects that the reaction is called forth by the style being forcibly bent rather than irritated by touch.

In Darwin's "Fertilisation of Orchids" the mechanism by which Catasetum shoots out its pollen-masses was for the first time described. Haberlandt has now shown that in *C. Darwinianum* and *macrocarpum* the "antennæ" which receive the stimulus, and transmit an influence to the rostellum, are provided with sense organs. His drawings (especially Taf. iii. Fig. 7) fully confirm his remark that the tactile papillæ bear a striking resemblance to those on the filaments of Opuntia and Portulaca.

In an undetermined species of Catasetum a most remarkable divergence from the type occurs. Tactile papillæ are wanting, and the antenna is converted, by the development of mechanical tissues, into a vibrissa or lever; it is capable of bending near the base, and obviously functions like filaments in Dionæa,[1] where the movement of the stiff apical part deforms the percipient joint or hinge near the base.

Allied to the tactile papillæ are the *Fühl-tüpfeln* or tactile pits discovered by Pfeffer in certain tendrils, inasmuch as by their means the protoplasmic prolongations which fill the pits are brought close to the free surface, and in such a position that they are liable to deformation by contact. Haberlandt describes these structures in detail in a variety of genera, and gives drawings of several, including the cases where a relatively large crystal is included in the pit, an arrangement which must have the effect of a stone in a man's shoe in increasing the sensitiveness to contact.[2]

For the interesting account of the minute tactile pits in the tentacles of Drosera, the reader is referred to the original. The remaining sense organs described by Haberlandt may be placed together, although by the author they are subdivided into tactile hairs, tactile bristles, stimulators, &c. Their essential character has already been referred to in describing an unnamed species of Catasetum; it is the occurrence of a stiff terminal part the movement of which deforms either the base or the tissues from which it springs. A simple example occurs on the contractile stamens of *Centaurea montana*; here the sense organs consist each of a simple, strongly built hair, the movement of which acts on the thin-walled basal joint. Other organs of the same essential type have been described[3] in Aldrovanda, but here the sensitive joint is not at the base, but in the middle of the hair.

One of the most interesting points in the book is the discovery of similar organs in Mimosa and Biophytum. The sensitive lower surface of the pulvinus of *Mimosa pudica* bears a number of obliquely lying bristles, and Haberlandt finds that the familiar reaction follows a touch applied to one of these. To convince himself of the fact the observer must, it seems, select a plant not in the highest condition of irritability; with a slightly sluggish plant it is easy to convince oneself that the bristles are the most sensitive part of the surface. The bristles are of several types, of which the most interesting is described as the "cork-squeezer" pattern.

In the angle between the bristle and the surface of the pulvinus is a projecting mass of cells, which will necessarily be squeezed when pressure is applied to the end of the bristle. The same mechanical contrivance is found among the Oxalidæ on the leaves of Biophytum, the lever being in this case a stiff hair instead of a bristle. The author points out (p. 80) that the discovery of these organs throws light on the question of the biological meaning of the irritability of Mimosa. Their existence does not seem compatible with Sachs' view that the response to contact is useful as a protection against sudden violent hail- or rain-storms. On the other hand, it lends support to Pfeffer's theory that the movement of the leaf stalks serves to warn off small creeping insects, &c. In Java and Singapore, where *Mimosa pudica* is an introduced weed, Haberlandt has seen the leaves react to visitors of this type.

The book concludes with a short section on the comparison of the tactile organs of plants with those of animals, in which the interesting point is brought out that in insects the lever-like or hinged hairs bear a distinct resemblance to corresponding structures described by the author in plants.

FRANCIS DARWIN.

[1] Haberlandt, "Physiologische Pflanzenanatomie," Edit. ii., p. 481.
[2] See also Haberlandt, "Physiologische Pflanzenanatomie," Edit. ii., 1896, p. 478.
[3] Haberlandt, "Physiologische Pflanzenanatomie," Edit. ii., 1896, p. 480.

A NEW TREATISE ON THE CALCULUS.

An Elementary Treatise on the Calculus, with Illustrations from Geometry, Mechanics and Physics. By George A. Gibson, M.A., F.R.S.E., Professor of Mathematics in the Glasgow and West of Scotland Technical College. Pp. xix + 459. (London: Macmillan and Co., Ltd., 1901.) Price 7*s.* 6*d.*

AMONG several notable characteristics possessed by this work, the most prominent appears to be the severity of its logic. In one important respect it differs also from the usual English mathematical treatise—it seems to speak to the student, warning him against too probable error and giving him advice. This is a feature which should be encouraged. The aim of the writer of a text-book should be to educate his reader, frankly recognising the imperfections of human nature, and not merely to set forth a work of unassailable art full of unimpeachable truths.

While applied mathematics is the great field for the exercise of such a method of treatment—since erroneous views on the part of students are at once more probable and more numerous in this domain than in others—the calculus is probably, in the field of pure mathematics, the subject in which a student most needs the anticipation of errors and difficulties; and the really philosophical student will find in Prof. Gibson's treatise a work which

seems to leave no difficulty unnoticed, the Scottish love of pure logic being prominent throughout.

It is not a work for the mere smatterer who aims only at learning rules and practical processes, regardless of the logical foundations; and in its various applications and illustrations it lays under contribution the sciences of electricity, magnetism and heat. The student, however, who has no knowledge of these subjects is not hindered by the introduction of them; for they can be passed over for a more convenient season, and they are used only as examples which do not belong to the essence of the treatise.

The first hundred pages (five chapters) of the book are devoted to several subjects which are generally dealt with in other treatises—such as the elements of coordinate geometry, the most prominent properties of the conic sections, and the discussion of the limiting value of $\left(1+\frac{1}{m}\right)^m$ when $m=\infty$. In these chapters, also, there is a good deal about the graphs of functions, algebraic, exponential and trigonometric. It is possible that Prof. Gibson need not have included the portion on conic sections, since students are certain to make a special study of this elsewhere.

The whole of chapter iv. is devoted to the exposition of rates and limits, and it is minutely logical and illuminating. We cannot imagine Prof. Gibson as accepting that truly wonderful measure or definition of a variable rate which we often find in works on dynamics when their authors treat of a variable velocity:

"the velocity, when variable, is measured by the distance that would be gone over in a unit of time if the velocity remained constant and equal to that which it is at the particular instant"!

It is in chapter vi. that the special subject of the treatise begins formally with the discussion of differentiation; and here Prof. Gibson adopts the good plan of associating in the mind of the student, from the outset, both the "derivative" and the function from which it comes; in other words, the student is learning his integral as well as his differential calculus, and he is exercised in the art of deducing the function which has a given one for its derivative. There is here a section specially devoted to the properties of hyperbolic functions. The names of these functions leave much to be desired, inasmuch as several of them suffer from the fatal defect of being unpronounceable. Thus, how are sinh x and tanh x to be pronounced? And does not cosh x suggest merriment? A very simple change would remove the first difficulty. If the prefix *hy* were put to each of the trigonometrical functions, all the names would be pronounceable and not too long. Thus *hysin x*, *hytan x*, &c., would at once be pronounceable and indicate the hyperbolic nature of the functions.

Prof. Gibson's paragraph (p. 157) on the conduction of heat, together with the accompanying page of exercises, is marked by his accustomed love of clearness, but it may not be appreciated by the student of pure calculus unless he happens to have studied previously comparatively advanced physics. It is, however, a good principle to keep the purely mathematical subject as much as possible in touch with physics. There is a dangerous tendency visible in some writers to overload the special subject in hand with applications and technicalities in several other subjects, with the result that much of the work is unappreciated by the student. In this respect, however, Prof. Gibson is more judicious than many other authors. The work abounds in warnings to the student against possible (and probable) errors, and the author never hesitates to give a useful collateral piece of information, which it is desirable that the student should have, whenever it can be simply and shortly conveyed—as, for instance, at p. 175, when the different ways in which a battery of a number of cells may be arranged are discussed. This would be regarded by the typical English author as quite outside the bargain which he considers himself to have made with his reader—to give him the truth, the whole truth, and nothing but the truth, with no extra useful information, advice, or warning.

There is also plenty of the graphic method of illustration in the book in dealing both with the processes of differentiation and with those of integration.

In dealing with partial differentiation (chapter xi.), the author has a few pages devoted to the elements of coordinate geometry of three dimensions, which will, probably, be found by the student who has advanced thus far to be unnecessary. The equations of thermodynamics and also Laplace's spherical harmonic equation supply appropriate applications of the subject of the chapter.

This is followed by a very good chapter on the theory of equations, in which the methods of approximate solution are well discussed, together with the reliance to be placed on successive approximations.

The successive reductions of the binomial integral $\int x^{m-1}(a+bx^n)^{\frac{p}{q}}dx$ are dealt with rather too shortly at p. 295. It is strange that such an old work as Hymers's "Integral Calculus" should have treated these integrals in such a helpful, complete, and systematic manner, and that Hymers' simple rules for reduction in any specified case should have been quite neglected or overlooked by subsequent writers.

The mechanical method of integration by Amsler's planimeter, together with the allied geometrical theorems on the displacements of a line, is given in chapter xiv. Near the end of the book there is a thorough discussion of series, their convergency, divergency, &c. The last chapter, xx., is devoted to a short discussion of linear differential equations; and it is to be hoped that this chapter will be considerably lengthened in the next edition with a good discussion of the symbolical method of integration—a subject on which we should expect Prof. Gibson's acute logic to be very illuminating.

Finally, the work seems to be exceptionally free from misprints. We notice the extraordinary letter "O" in the centre of fig. 65, p. 315, which looks like a branch of the curve, but is really the *origin* of coordinates. See a similar defect in fig. 83, p. 362; and in line 6 from the end of p. 379 the term $p^r n$ should be ${}_pr_n$.

GEORGE M. MINCHIN.

LECTURES ON ELECTRICITY AND LIGHT.

Leichtfassliche Vorlesungen über Elektrizität und Licht. By Prof. Dr. G. Jaumann. Pp. xii + 375. (Leipzig: Barth, 1902.) Price Mk. 6.

IN a book of 370 pages it is quite impossible that the subjects of magnetism, electricity and light could be treated in anything but a scrappy manner, so that we cannot expect from Prof. Jaumann anything more than a general view of the subjects treated. The book under review arose from a course of lectures at Prague for beginners at the University and teachers in the secondary schools, and is therefore of the nature of an outline to be used as a guide in study supplemented by other more technical reading. For this purpose, if there had been a good selection of references to standard treatises, the book would have been admirable; but, unfortunately, references are almost entirely absent. The author has undoubtedly made a most interesting volume and has treated the subject in a very original manner, dealing with the phenomena of magnetism, electricity and light from a physical point of view, using throughout the Faraday conception of tubes of force. The first eighty-four pages consist of an introduction dealing with stationary stream lines in the motion of a liquid to lead on to the conceptions of magnetic and electric lines of force. The analogies between liquid stream lines due to sources and sinks and vortices and lines of force due to charges and electric currents are well brought out, and considerable ingenuity is exercised in constructing cases of fluid motion to be analogous to the behaviour of lines of electric force when more than one dielectric is present in the field. It seems, however, curious to introduce, for the benefit of readers who cannot be supposed to understand lines of force, the lines of flow for a vortex filament in a steady stream as the first case of stream lines discussed. However, later on the author deals with the resultant of two sets of stream lines and shows how complicated cases can be built up out of simple cases. This might have been done at first and have led up to the more complicated and confusing cases which he presents to the reader at the very beginning. By means of a hot or cold region in the centre of a stream, he constructs stream lines which are analogous to the lines of force for a dielectric cylinder in a steady uniform electric field. The hot region is supposed to be produced by the sun shining on this part of the stream, the rest being in shadow. As a limiting case he has a region of vapour in the middle of the stream, and states in a footnote:—

"The conditions for a stationary state of flow with a region of vapour in the middle of the stream through which the water continuously flows are left undiscussed."

This part of the book is the most interesting, but it is somewhat questionable whether the method would be really of use to a student.

The electrical and magnetic parts of the book are clearly and, on the whole, well done, in spite of the limited space at the author's disposal. The elementary parts of electrostatics are very clearly and concisely explained. There are some points which are somewhat carelessly treated—for example, it is too much to say that the process of solution of zinc in sulphuric acid is completely explained by an electrolytic decomposition due to small currents set up on the zinc producing zinc oxide and setting free hydrogen, the zinc oxide then dissolving in the acid. It is difficult to see how this is a complete explanation.

The last few pages are concerned with Röntgen, Becquerel and kathode rays. The author here is rather unfortunate, as he makes several wrong statements, *e.g.* kathode rays charge bodies on which they fall frequently with a negative, but more often with a positive charge. Also Röntgen rays are stated to be probably light rays of smaller wave-length than ultra-violet rays, and kathode rays are stated to be probably longitudinal electric waves. These statements seem extraordinary in view of the Stokes-Thomson theory of Röntgen rays and the universally accepted emission nature of kathode rays.

The illustrations are good, but sometimes superfluous—for example, on p. 270 is an illustration of a dynamo attached to a steam engine, with no description whatever in the text, and the illustrations of telescope and microscope have no accompanying description.

On the whole, the book is very interesting and would prove extremely useful to students who have already been introduced to the elementary facts of the subjects.

OUR BOOK SHELF.

The Principles of Mechanics. Part i. By Frederic Slate, Professor of Physics in the University of California. Pp. x+299. (New York: The Macmillan Company; London: Macmillan and Co., Ltd., 1900.) Price 7*s.* 6*d.* net.

A Treatise on Elementary Dynamics. By H. A. Roberts, M.A. Pp. xi + 258. (London: Macmillan and Co., Ltd., 1900.) Price 4*s.* 6*d.*

AN interesting contrast can be made between these two little treatises on the methods of mathematical instruction in this country and America.

The English book is still full of elegant little calculus-dodging expedients, and no differential coefficient is allowed to appear, as it is intended for candidates for mathematical scholarships, who are still kept marking time so long over coordinate geometry as never to arrive at the calculus.

The American professor, on the other hand, addresses a class of college students of about the same age, but who have brought to their task a working knowledge of the calculus, as well as a good groundwork of experimental physics. This knowledge of experimental facts will enable the student to follow Prof. Slate's somewhat metaphysical presentation of the subject. Mr. Roberts has also incorporated the views of modern writers on the laws of motion, based mainly on Mach's "Science of Mechanics." This will make these treatises useful to students who are to become teachers in their turn; but Prof. Perry will say that they are unsuitable for the class of student he has in his mind, as the exercises and illustrations are throughout of the usual academic type, devoid of reality, or else based on microphysical conceptions.

Studien ü. d. Milchsaft v. Schleimsaft der Pflanzen. Von Prof. Dr. Hans Molisch. Pp. viii+109. (Jena: Gustav Fischer, 1901.)

PROF. MOLISCH gives a general account of the occurrence of laticiferous tissue and mucilage cells in plants, treating his subject specially from the point of view of the latex itself. He finds that the fluid is commonly acid or sometimes neutral in reaction, thus differing in this respect from protoplasm. He finds a curious form of vesiculated nucleus to be of common occurrence, and

describes the protein granules (first detected by H. Karsten), starch, oil, alkaloids and other contents in a number of examples. The protein granules are stated to arise (*e.g.* in *Cecropia*) inside special leucoplast-like structures, and elaioplasts are said to occur in the latex of croton. Of inorganic substances, calcium and magnesium are very often met with, but phosphorus, though present in the ash, is not apparently present except in organic compounds.

The mucilage cells and their contents are also discussed, and the author describes an apparently new substance, which he terms "luteofilin," as occurring extensively in monocotyledons and also in the Lobeliaceæ. A brief account of the aloin receptacles which are found in *Aloë soccotrina*, and some of the reactions and properties of their contents ends the volume.

Cast Iron: a Record of Original Research. By William J. Keep. Pp. xv + 225; with 117 illustrations. (New York: John Wiley and Sons. London: Chapman and Hall, Ltd., 1902.) Price 10*s.* 6*d.*

THIS volume possesses the distinction, which is yearly becoming less rare, of containing an account of original researches which are directly applicable to industrial work. Mr. Keep has devoted himself to the study of cast iron since 1885, and from time to time has expressed decided opinions regarding the best methods to be employed in foundries. In particular he has advocated the use of tests by which the amount of shrinkage during solidification is ascertained, his contention being that the quality of the metal to be tapped may thus be determined.

On p. v. a summary of the whole subject is given, so that a busy founder can in five minutes learn the practical results of Mr. Keep's teaching. In order to apply these results in practice, it is desirable also to read pp. 155 to 191, but the remainder of the book consists chiefly of the evidence on which the value of the recommendations rests, and is of interest only to those with a taste for science and a desire to understand what they are doing. The shrinkage test gives information mainly as to the percentage of silicon present, an addition of silicon being accompanied by a reduction in the shrinkage, and silicon, the author points out, acting through carbon, is the controlling element in cast iron.

Those founders who have not followed the course of scientific investigation on cast iron of late years would be well advised to study Mr. Keep's book, even if they do not agree with all that he says.

Test Papers in General Knowledge. By H. S. Cooke, M.A. Pp. vi + 97. (London: Macmillan and Co., Ltd., 1902). Price 1*s.* 6*d.*

THE author of this book has essayed a difficult task, and one cannot be surprised that he has achieved only a qualified success. The papers (eighty-five in number) are all short—too short, perhaps—but certainly do not lack variety. The work is intended for use in higher classes of primary schools, secondary schools and pupil teachers' "centres"; and the author's suggestion as to the use of the book is, "Each student should be provided with a copy, and a test (or more) should be given to the class one week, the answers of which should be returned the following week; this would give a fair opportunity of research in books of reference." There is much to be said in favour of such a plan. It may be doubted, however, if some of the knowledge which the students are thus set to obtain is of sufficient value to justify any expenditure of time on the attainment thereof. It is not easy to see, for example, what useful purpose is served by causing a youth to ascertain the length of time a letter would take to go from London to Moscow, or the cost of sending a parcel about two pounds weight to Winnipeg, or the price of a 100*l.* share in the Great Western Railway. Nor is much gained by knowing who wrote certain books unless something is also known of their nature, contents, and purpose. Are any of the pupils for whom the work is intended sufficiently grounded in scientific method to answer such questions as, "How did the teaching of Aristotle differ from that of Bacon?" or can any be expected to "compile (*sic*) a simple form of a Will?" It is only fair to the author to say that many questions are really admirable, *e.g.* "What results in history may be traceable to the discovery of the New World?" Scientific subjects, too, are, on the whole, well treated, and much useful knowledge must result from the efforts to answer thoroughly the questions asked. The general character of the papers, however, is hardly satisfactory from an educational point of view. Too much is made of mere knowledge and too little of the ability to use it. Hence one fears that they will ultimately prove tests of memory rather than of observation and resource, and that instead of "stimulating a many-sided *interest* in the facts of everyday life," the author will produce an irritating *curiosity* which grows on what it feeds. May we suggest a thorough revision? The book is worth it. Not only so, but in its present state there are many badly-worded questions and some few serious errors. We may attribute "in statu pupillar*ii*" and "Carmen Sylv*ia*" to careless proof reading; but the inaccuracies in the quotations in papers xi. and xxix. (to select two only) are quite unpardonable.

Class Book of Geology. By Sir Archibald Geikie. Fourth edition. Pp. xxi + 454. (London: Macmillan and Co., Ltd., 1902.) Price 5*s.*

SIR ARCHIBALD GEIKIE'S class-book of geology is likely to be one of those which will survive in the struggle for existence among the numerous handbooks of the subject which have been lately issued. There are many ways of accounting for the frequent appearance of new text-books. One of them, though perhaps not the principal one, is to be found in the varied requirements of pupils and teachers, and when an elementary work has run to a fourth edition, as in this case, we may fairly assume that it has met a want.

It is not easy to write a good text-book. This arises sometimes from the difficulty of observing a due sense of proportion all through, notwithstanding that the author is vastly more interested in some branches of the subject than in others, while sometimes it arises from the necessity of bringing before the student many subjects which are still matters of controversy, and the author has either to make positive statements in accordance with what he thinks the best supported theory or delicately to hint that doubts exist.

One reason why this class-book has been so successful is that Sir Archibald has covered all the most important parts of the subject without distracting the reader with controversy. In this he was, of course, much helped by the existence of his larger work, the "Text-Book," to which more advanced students can be referred.

The most important alterations in this edition are the introduction of descriptions and explanations of the phenomena of tectonic geology, for which his illustrations have been drawn chiefly from America, where these branches of the subject have been followed up with so much zeal and skill, and where recent travel has enabled Sir Archibald to examine the evidence and discuss the interpretation of the phenomena on the spot with his scientific friends on the other side of the Atlantic.

May he long enjoy the leisure he has so well earned, and still employ it in keeping his valuable educational and descriptive works up to date.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

Transport of Molluscs by Waterfowl.

YESTERDAY (March 19) I witnessed an interesting instance of the capacity of quite small waterfowl to carry aquatic molluscs of considerable size. A pheasant-tailed Jaçaná (*Hydrophasianus chirurgus*), which was at large, with partially clipped wings, on the tank in the Museum grounds, had attached to one of its feet a fresh-water mussel well over an inch long, which remained there for about an hour and a half to my knowledge.

The Jaçaná, although quite a small bird, only about the size of a turtle-dove, nevertheless flew quite as well with this burden as without, covering as much as sixty yards at a flight, with its legs naturally extended behind.

Of course the partial clipping of its wings hindered it from rising high and going off altogether; but had it not been thus handicapped I am sure it could have transported its burden for miles if forced to leave the tank.

I have had more than one specimen of this Jaçaná in which a toe, or part of one, was missing, an accident which might possibly be due to the pinch of a bivalve behaving as described above. A fish or turtle might more probably be guilty of such amputation, although the Jaçaná's slim green toes look very like weed-stems when it is swimming, and the resemblance might be protective so long as the bird floated quietly without paddling.

I find from my notes that six years ago I observed one of some Tree-ducks (*Dendrocycna javanica*) which I was then keeping on this tank, with what appeared to be a big water-snail remaining attached to its toe for some time.

Indian Museum, Calcutta, March 20. FRANK FINN.

Preservatives in Milk.

I HAVE been astonished to learn from your English Government Blue-book about the scandalous, unnecessary and unnatural practice prevailing in England of putting drugs into milk for purposes of its preservation—a wrong and unnecessary act of adulteration. It is amazing that it should be pursued and for one moment permitted. Your highly appreciated publication will, I am certain, feel the necessity of defending nature's produce. All milk drawn from healthy cows is yielded sterile. The remedy against the use of drugs and late-refrigeration, &c., is to purify and preserve the milk in its natural sterile condition by quickly—on drawing it—aërating, cooling and refrigerating it down to the non-decomposing and non-fermenting temperature of 50° Fahrenheit or lower at the farms and rural factories before being sent off from the country, and having it conveyed, so chilled, into ordinary cold stores—the same as doubtless most of your butchers have, and with less reason—at the town dairy premises. Meat is so preserved and so conveyed, I understand, in England, and it is not nearly so susceptible to decomposition. The totally unnecessary consequences that are revealed by your recent official inquiry are scandalous. Dairy men evidently—and must constantly—find the milk they have to sell, not only in an advanced, but also dangerous state of fermentation, which, in self-interest, they can only, however, temporarily suppress by the processes of drugging, late-refrigeration and other disorganising practices, through neglect in the country of purifying and cooling the milk at once when drawn warm from the cow. There are plenty of simple portable appliances to use for the purpose, so why should not English farmers have them, and rural ice depots near railway stations for refrigeration of milk, as well as Continental, and notably American, country milk producers? Your farmers and milk distributors certainly need reform in their system, for you cannot possibly compete in quality of milk, butter or cheese with other countries where immediate purification by the practice of quick aëration and refrigeration of milk is pursued down to a non-fermenting temperature as soon as possible after being drawn from the cow. I have heard of a new method of milk preservation based on the infusion of gases (oxygen and carbonic acid) into milk. Whatever may be the merits of this new process I am not prepared to say, but if drugs are to be prohibited, this infusion of gases should be swept away with the rest of the doctoring methods of milk. By all means let the prohibition be utterly complete, and thus allow the consumer to drink nature's production and not chemical compounds. In this country (Belgium) the use of any drugs has long been prohibited, and our milk is superior and never complained about, and were drugs permitted a general protest would result. L. J. SERIN.

Mont-sur-Marchienne, Charleroi, Belgium.

[Mr. Serin does not seem to be aware of the fact that the Departmental Committee on the use of Preservatives in Food condemned the use of preservatives in milk. (See NATURE, December 5, 1901, p. 102.)—EDITOR.]

Rearrangement of Euclid Bk. I., pt. i.

As very widespread attention is being paid to the question of reform in geometrical teaching, and as a good many teachers are convinced that in this country the reform must be in the direction of a modification of Euclid's elements, I should be glad to elicit opinions as to the following rearrangement of the theorems in the first part of Book I. (to prop. 32, inclusive).

First, the theorems relating to angles made by two intersecting straight lines, viz., I. 13, 14, 15.

Then those relating to parallels, viz. 27, 28, 29, 30. Prop. 27 can be proved by superposition; for, if a transversal EF crossing two lines AB, CD makes the alternate angles equal, the portion BEFD can be exactly superposed on CFEA, so that, if AB, CD meet towards B, D, they must also meet towards C, A, which is impossible, ∴ AB, CD are parallel. I. 28 follows from I. 13; and 29, 30 from Playfair's axiom.

By taking these propositions early, we are enabled to rearrange the propositions respecting triangles in such a way that connected propositions are juxtaposed, which is of great assistance to the memory and to the growth of orderly ideas in the pupil's mind. The natural order would be to take those propositions which relate to a single triangle and then those which deal with the comparison of two triangles.

First, the fundamental theorem I. 32, with its corollaries, including I. 16, 17, and Euclid's axiom (which is the converse of 17).

Then 5, 6 with their extensions, viz. 18, 19, to which might be added the corollary that the perpendicular distance of a point from a straight line is the shortest.

Then 20, 21.

Then follow the *congruence* theorems 26, 4, 8, to which might well be added the conditions for the congruence of right-angled triangles in what would otherwise be the ambiguous case.

And lastly 24, 25, which are extensions of 4, 8 in much the same way as 18, 19 are extensions of 5, 6.

If to these are added the simple *locus* theorems regarding the locus of points equidistant from two given points, and the locus of points equidistant from two intersecting straight lines, the whole forms a well-rounded-off "First Part" of the deductive course.

The only innovation suggested here is the early introduction of the theorems relating to parallels. The effect of this is to render the course much more compact and orderly than is possible if the theory of parallels has to be approached through I. 16.

It is on the desirability (and the possibility, from the point of view of examinations) of this innovation that I earnestly desire opinions.

There is one other modification tacitly adopted in the above arrangement, and that is the cutting out of "constructions" from the deductive course. I believe this requires no defence. It is the first and greatest necessity, for any real improvement in geometrical teaching, that the course of constructions should be a parallel course to that of theorems, and not part of it.

Coopers Hill, April 2. ALFRED LODGE.

Protoplasmic Networks.

IN a presidential address delivered at Yale (*Contrib.*, Botanical Laboratory, Univ. Pennsylvania, ii., 1901, p. 183), Prof. Macfarlane announces his discovery of a "linin and chromatin" network continuous with the nuclear chromatin distributed through the protoplasm of plant cells. Certain other observations lead Prof. Marfarlane to suggest that these run from cell to cell, so that there is continuity, not only of cytoplasm, but also of the "hereditary substance."

It is now some three or four years since I discovered fibrils, hovering upon the limits of vision aided by the best oil-immersion lenses, which ran from nucleus to nucleus in the retina of vertebrates. The first hints were slowly followed up, and I have now established the fact that all the nuclei of the retina are connected together, by fibrils coming from the intra-nuclear networks, into a nuclear system; that is, into a reticulum of which the individual nuclei are the nodes.

As a student of the retina, my first interest in this nuclear system pervading the cytoplasmic framework turned upon the fact that it might supply us with the hitherto undiscovered link between the retinal nerve strands and the rods. This I have found to be the fact; the full details are described in a paper which I hope shortly to publish.

The importance of this discovery cannot, however, be confined to the retina. Not only have I succeeded in discovering similar inter-nuclear connecting fibrils in other tissues, *e.g.* in the brain, but the simple fact that in the retina they supply the paths for the nerve stimuli shows that they must lie somewhere nearer the basis of the morphology and physiology of protoplasm than we have hitherto succeeded in reaching.

In discussing the nature of this nuclear network and its bearing upon the "cell" doctrine, I have described a number of observations tending to show its relations, on the one hand, to the chromatin stored up in the nuclei, and, on the other, to the cytoplasm which forms the supporting framework of the retina. I have, further, endeavoured to show that it brings fresh light upon more than one difficult problem, for example, on the morphology of nerves and the nature of their peripheral terminations.

Several lines of argument made it almost certain to my mind that a similar nuclear network must also exist in plants, and I have little doubt but that Prof. Macfarlane's suggested continuity of the "hereditary substance" from "cell" to "cell" will ere long be demonstrable under the microscope.

I have suggested the term protomitomic as applicable to this nuclear system, that being as nearly as possible simply descriptive. The nuclear filaments, it is true, seem to supply some of the requirements of Strasburger's hypothetical kinoplastic fibrillar system. But the term kinoplasm, which I should have preferred using, has already passed into current use for structures which may have little or nothing to do with this nuclear connecting system, a preliminary announcement of which I have felt justified in making since my attention was called to Prof. Macfarlane's address. HENRY M. BERNARD.

Clapham, S.W., March 25.

Beechen Hedges on Elevated Ground.

VISITORS to Buxton, who are observant of trees, have been exercised during the winter by noticing how the smaller beech trees, where isolated, and especially the beechen hedges, where unsheltered, have maintained their foliage through the winter, contrary to the habit of deciduous trees.

The spray enclosed was plucked, this morning, from a tree about 12 ft. high, one of a number similarly clothed, bounding the western side of the pavilion grounds where exposed to the force of the storm winds, and standing at the elevation of the town, about a thousand feet above the sea; and, in the park close at hand, are long lengths of beech hedges exhibiting this appearance. In Ashwood Dale, half a mile away and well sheltered, the larger beeches are as leafless as the lime and the ash.

I see nothing in Kerner's "Natural History of Plants" to account for this departure—this tree being spoken of as constant in dropping its leaves—except the remark that the beech is most resourceful and to be regarded as a "weed" amongst trees, and calculated to oust others, where unhindered by human agency. Is this holding of the leaves, until pushed off by the growing points, to be regarded as a protective device in exceptional circumstances, and is this occurrence observable in young plants in similar elevated and exposed positions? WM. GEE.

Barlboro' Cottage, Spring Gardens, Buxton, March 31.

Meristic Variation in Trochus Zizyphinus.

ON recently examining a number of specimens of *Trochus zizyphinus* collected at Plymouth in September 1900, it was noticed that one specimen exhibited a peculiar abnormality, viz. the presence of two supernumerary eyes on the right side (Fig. 1). On the left side of the animal both cephalic tentacle and ocular peduncle were perfectly normal. The right cephalic tentacle was also normal, and the ocular peduncle of this side, though bearing three eyes, presented only a slight furrow indicating a partial division between the original eye and the two which are secondary and supernumerary (Fig. 2). Several cases of supernumerary eyes in Gasteropods have already been recorded, and in some cases (for example, *Patella*, *Littorina*) duplication of the eye is accompanied by duplication of the cephalic tentacle.

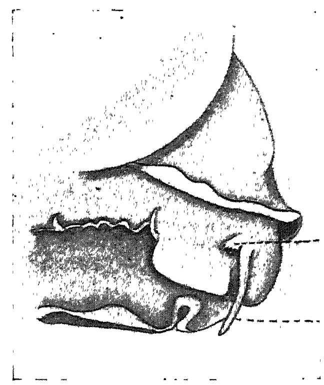


FIG. 1.—Head of abnormal specimen of *Trochus zizyphinus*, seen from the right side.

Double eyes have also been recorded in *Helix*, *Clausilia*, *Phidiana*, *Murex*, and *Sub-emarginula*[1]; in the latter, supernumerary eyes were found on both right and left sides, though in the majority of other cases they were present on one side only. It would thus appear that only double eyes have been so far recorded, and that the presence of three eyes on the right side of this abnormal specimen of Trochus is, apparently, unique. All three eyes are perfectly formed, each being provided with crystalline lens, retina, and optic nerve, thus all of them were, in all probability, functional during life.

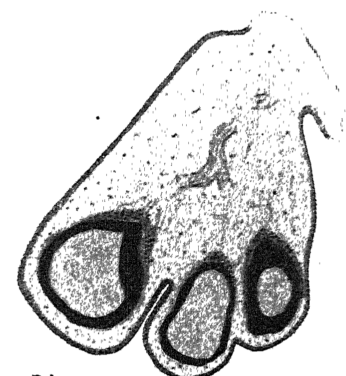


FIG. 2.—Longitudinal section of right ocular peduncle, showing the three eyes in section.

So far as can be made out from the examination of an unfortunately incomplete series of longitudinal sections through the right ocular peduncle, the innervation of the eyes is derived from a single optic nerve arising from the right cerebral ganglion. This nerve bifurcates, one branch going to the primary eye, the other branch again dividing into two, to supply the two secondary supernumerary eyes. W. B. RANDLES.

Royal College of Science, London, March 25.

[1] For particulars and references, see Bateson's "Materials for the Study of Variation," pp. 279, 280.

Formula for the Perimeter of an Ellipse.

WILL one of your mathematical readers kindly state whether the following empirical formula gives a nearer approximation to the perimeter of an ellipse than that usually given in pocket-books of formulæ?

x and y stand for axes.

$$\text{Perimeter} = \pi\left\{\frac{x^{\frac{\log 2}{\log\pi - \log 2}} + y^{\frac{\log 2}{\log\pi - \log 2}}}{2}\right\}^{\frac{\log\pi - \log 2}{\log 2}}.$$

Molesworth's book gives the following:—

T = semi-major axis; C = semi-minor axis.

$$\text{Perimeter} = \tfrac{1}{2}\pi[\sqrt{2(T^2 + C^2)} + T + C] + 0{\cdot}2078(T - C).$$

State School, Beaudesert, H. TOMKYS.
Nr. Brisbane, Queensland, Australia, February 26.

Sounds Associated with Low Temperatures.

THERE is one place where the sounds mentioned by Mr. Cave (p. 512) can be (or used to be) heard to perfection. This is at the lower end of Beaumont Street, Oxford, where the road widens out in approaching Worcester College. The pavement and the fence adjoining it take a crescent form, and while walking on the former quite a loud metallic musical note may always be heard. The fence consists, or consisted, of boards, in front of which are iron palings, the uprights of which had a square section. SPENCER PICKERING.
Woolacombe.

Sun Pillars.

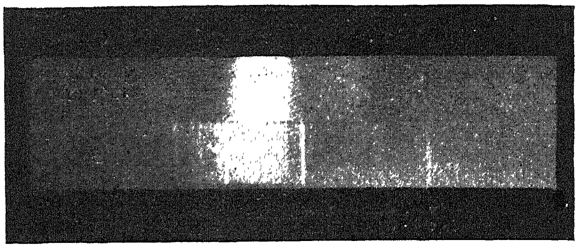
THIS evening a sun-pillar was again visible at Swindon, not so brilliant or long-lived as that which recently attracted such widespread attention, but nevertheless quite definite. I first observed it about 6.15 p.m., when the sun was a few degrees above the horizon. It was of a clear yellow colour, and extended from the dull-red sun vertically upwards. The sun set behind a bank of murky haze, and shortly after—about 6.45—the pillar had faded from view. H. B. KNOWLES.
Swindon, April 7.

LUMINOUS BACTERIA.

LUMINOUS bacteria constitute a group of organisms which under certain conditions have the power of emitting light. They occur principally, if not entirely, in sea-water. It is, however, doubtful whether they give rise to any general luminosity of the sea, such as is caused by noctiluca and other relatively high forms of marine life, although it is possible that in the tropics, where the amount of non-living nutritive material is present in sufficient quantities, that bacteria do occasionally cause a general luminosity; but the opportunities of verifying this are rare. One organism in particular, the *Photobacterium Indicum*, from its forming a surface pellicle in artificial fluid cultures, which is very luminous, may at times cause luminosity of sea-water at the surface. It is remarkable that an unicellular organism such as a bacterium should have the power of emitting light. There is no evidence of any special structure in the cell itself, and in the present state of our knowledge it is difficult to regard it as other than a result of functional activity, exactly as heat is evolved by other forms of life, as an accompaniment of the metabolism of the cell. What is, however, the exact difference between the evolution of heat by some organisms and that of light by others it is at present impossible to say. Oxygen is absorbed in both instances and carbon dioxide evolved, but there is evidently some other factor of which at present we know nothing. The fact that light and heat are manifestations of the same form of energy may apparently simplify the matter; but further consideration shows that there is a different problem to be solved in each.

We are not acquainted with any artificial method of light production, in which chemical action takes place, where light is evolved except through the medium of heat, yet in nature, by a simple cell, light is produced which is apparently unaccompanied by any invisible radiations whatever.

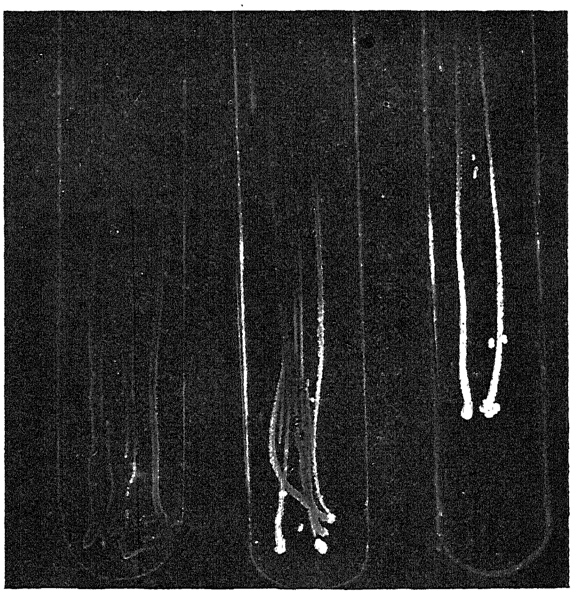
These organisms are sometimes referred to as "phosphorescent," but the term is hardly a suitable one, as the phenomenon is likely to be regarded as analogous to the emission of light by inert chemicals and minerals, or to the continued glow of vacuum tubes after an electrical



G F C

FIG. 1.—(*a*) Spectrum of luminous bacteria. (*b*) Spectrum of hydrogen for comparison.

current of high potential has been passed through them. In all marine light-producing animals, the light is not emitted continuously, but is given out at intervals in response to some stimulus or irritation. It is possible that bacteria act in the same way, but it is difficult to determine this point, as the individual organism is not sufficiently luminous to enable the observer to study it under the microscope by its own light. In fluid cultures they apparently respond to any agitation or excitation so



a *b* *c*

FIG. 2.—Cultures of different ages. (*a*) seven weeks; (*b*) three weeks; (*c*) young culture.

long as the supply of oxygen is maintained, but they can be kept in a luminous condition on fluid media if oxygen is continuously supplied in other ways, although they may remain at rest. This can be done, for instance, by allowing the wool plug, used to close the orifice of the glass vessel containing a fluid culture, to become saturated with the culture, when the plug will continue to glow for days, although the culture in the vessel may only become luminous when agitated. This points to

the agitation only resulting in the introduction of fresh oxygen and not as being a direct exciting cause.

The number of species isolated up to the present is about twenty-five, but it is more than probable that some of these are identical, or at any rate closely related.

In artificial cultivations, these organisms grow best on a medium containing a considerable percentage of a soluble chloride in addition to the nutritive material. They will grow on an ordinary peptone-beef-broth gelatine medium, but they do not all emit light, and none of them emit the maximum amount they are capable of producing. The best results are to be obtained by adding to the culture medium 2·6 per cent. of sodic chloride, ·075 per cent. of magnesia chloride, and ·3 per cent. of potassic chloride.

Either of the chlorides which occur in sea-water, if added to a nutritive medium in suitable proportions, will cause some luminosity, but the results are not so good as on the medium mentioned.

In the case of fluid nutrient media, some means must be taken to replenish the oxygen, as the amount held in solution is speedily exhausted. Either free oxygen can

FIG. 3.—Plate culture of luminous bacteria.

be allowed to bubble through the medium, in which case very brilliant cultures can be obtained, or frequent agitation can be resorted to.

The temperature at which these organisms grow is variable. Those found in northern latitudes can grow and remain luminous at 0° C., the optimum temperature being about 15°, at which reproduction is very rapid and luminosity at its maximum. Some organisms found in the tropics grow, however, at a much higher temperature, but none of them have an optimum as high as blood-heat, 37° C. Spectroscopically, the light emitted by these organisms is confined to a small portion of the visible spectrum, never extending into the ultra-violet or infra-red. Visually it only includes the green and blue, and photographically it extends very slightly further towards the violet.

Fig. 1 shows a photograph of the spectrum of this organism (*a*), with the spectrum of hydrogen beneath for reference (*b*). It will be seen that the former is continuous, and the brightest portion lies between the lines F and G. There is some extension towards the D line, but it is not well marked, and it is only with very long exposure that this becomes evident. This result has been confirmed by using a spectroscope with a quartz system, but owing to its low dispersion, the photograph here shown was regarded as more suitable for purposes of illustration.

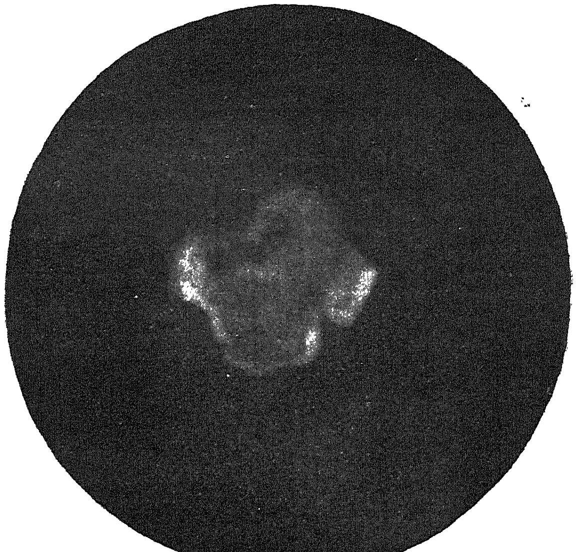


FIG. 4.—Single colony of luminous bacteria, magnified about forty-five diameters.

Figs. 2, 3, 4 and 5 are all cultures of luminous organisms, photographed entirely by their own light.

Fig. 2 is a photograph of three growths on gelatine to show the power of emitting light for long periods. The first one (*a*) is the oldest growth, some seven weeks old, in which, as always happens, the light has diminished at the centre of the streak, but is still bright at the edges, where reproduction of the organisms is still taking place. The next (*b*) is a three weeks' growth, while (*c*) is a young culture, showing that the streak is equally bright throughout.

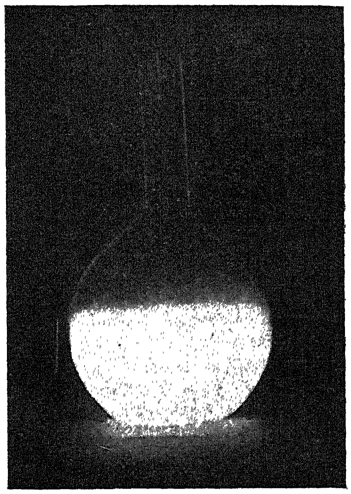


FIG. 5.—Fluid culture of luminous bacteria.

Fig. 3 is a plate cultivation one week old to show the individual colonies. Fig. 4 is a single colony magnified about forty-five diameters, showing that even in young bright growths the emission of light is greatest at the edges,

where reproduction is proceeding most actively. Fig. 5 is a large flask containing a fluid culture through which air was passed continuously while the photograph was taken.

My investigations on these organisms have been carried out at the Jenner Institute of Preventive Medicine, and I am greatly indebted to Dr. Allan Macfadyen for help and advice during the progress of the work.

J. E. BARNARD.

INTERNATIONAL COMMITTEE OF WEIGHTS AND MEASURES.

THE International Committee of Weights and Measures at Paris has just issued an account of its business and proceedings for the past year.[1] It would appear from the report of the director of the International Bureau (at Sèvres, near Paris), made to the Committee at their session in October last, that the work of the Bureau has, under the directions of the Committee, included:—Research as to the mass of a cubic decimetre of water (giving for the specific mass of water at 4° C. a value equal to 0.9999707); the study of dividing engines; investigations as to the dilatation of metals, the precise measurement of temperature, &c. The ordinary verification work of the Bureau during the past year has included:—The re-verification of metric standards (metres and kilogrammes) for the High Contracting States who have given adhesion to the Metric Convention, 1875; the verification of standards (particularly thermometers, and decimetres) for a large number of scientific and official authorities; and the installation of new bases for geodetic measurements. We are glad to see that the Committee has now been able to extend and repair its laboratories at the Pavillon de Breteuil and to perfect its arrangements for undertaking electrical measurements.

We congratulate the new secretary of the Committee, Prof. P. Blazerna (Rome); who has succeeded the late secretary the lamented Dr. A. Hirsch; on the present issue of the *Proceedings* of the Committee. Four useful appendices are attached to the volume, including:—Annexe i., on the danger of introducing normal secondary standards in the definition of metric units; a *résumé* (annexe ii.) of legislation in different countries, derived from reports presented to both Houses of Parliament by the British Foreign Office in 1900 and 1901; and particularly annexe iv., which recapitulates the decisions of the Troisième Conférence Générale held at Paris last October, as to the definition of the metric units, metre, kilogramme and litre, and the true measurements of standards of those units. The Committee also was much engaged in the discussion of these definitions, which are now published in the *Compte rendus* des Séances de la Conférence (Paris, 1901).

The members of the Committee included MM. Arndsten, D'Arrillaga, Benoit, Blazerna, De Bodola, Chaney, Cornu, Egoroff, Gautier, Hasselberg, Hepites, Von Lang, De Macedo; and M. Mendeléeff, formerly an active member of the Committee, has now been named one of the honorary members of the Committee.

Last year the annual budget of the Committee was, as in previous years, fixed at 75,000 francs; but at the meeting at Paris in October 1901 of the General Conference it was proposed that the budget should be increased to 100,000 francs annually. This proposition did not, however, receive the support of the delegate from Great Britain, but we are now glad to see that the Treasury has given its sanction for the increase in the proportionate contribution payable by this country to the Committee, based on the annual budget of 100,000 francs.

[1] "Comité International des Poids et Mesures." Procès Verbaux. Pp. 281. (Paris: Gauthier Villars, 1902) 1 vol.

SIR JOHN DONNELLY, K.C.B.

SIR JOHN DONNELLY, whose death occurred on Saturday last after a painful illness of more than six weeks, will probably be best remembered for his unceasing and devoted service in developing and administering Governmental schemes for the promotion of scientific education in this country. Soon after the end of the Crimean War, through which he served with distinction as a Lieutenant of Royal Engineers, being twice mentioned in despatches and recommended for the Victoria Cross—an honour, however, rather unjustly withheld from him—he was appointed to the charge of a detachment of Royal Engineers quartered at the South Kensington Museum. At that time this institution was but newly born, under the fostering care of the Department of Science and Art, the principal permanent chief being Sir Henry Cole, who formed the highest opinion of Donnelly's marked abilities as a clear-sighted, shrewd and wholly trustworthy young officer. About 1858-1859, Captain Donnelly succeeded the late Lord (then Dr.) Playfair as inspector for science, and a general scheme of grants applicable to the whole country was formulated and set in operation. The subjects of science towards which instruction in aid was obtainable were at first few. Among the examiners was Huxley, with whom Donnelly came to be closely associated. This close association ripened into an intimate and affectionate friendship. It is probable that to few, if any, other men did Donnelly turn with equal confidence for counsel and advice more frequently than he did to Huxley.

From a beginning of thirty-eight local science classes and schools with 1330 students in 1860 were developed the existing 2000 classes and schools attended by at least 160,000 students. Grants for practical work in laboratories at such schools were made by the Government in 1870. As early as 1867 Donnelly had a large share in putting forward a scheme for aiding local efforts to establish local scholarships and exhibitions to assist the higher instruction of students in science.

Besides the management and care of these wide-reaching operations, he assisted in reorganising the old Royal College of Chemistry in Oxford Street and the School of Mines in Jermyn Street which became in 1890 the Royal College of Science, of which the first dean was the late Prof. Huxley. In 1868 Donnelly was appointed on a commission to consider what steps should be taken to constitute a separate Department of Science and Art for Ireland, and, acting also as secretary of the commission, he drafted its report. The commission could not see its way to reporting in favour of establishing a separate Department, and up to Donnelly's retirement in July 1899 various State-aided institutions in Ireland were subject generally to his control as Secretary of the Science and Art Department, to which office he was appointed in 1884, having held the office of Director for Science from 1873.

To develop the Museum of Science as a worthy companion to the Museum of Art at South Kensington, Donnelly pressed upon the notice of his chiefs the desirability of holding a very important and successful loan exhibition of scientific instruments and apparatus, which was opened in 1874 by Her Majesty Queen Victoria in person. This led to the formation of a museum of scientific apparatus for teaching and research. For many years after the retirement of Sir Henry Cole in 1873, Donnelly was untiring in his exertions to secure Parliamentary grants for the completion and erection of properly devised permanent buildings to house the Museums of Art and Science, the component sections of which were dispersed throughout in temporary and straggling makeshift galleries and sheds. The obvious scandal that a Government could permit the existence of such a

condition gathered strength. Opponents and friends of the Department of Science and Art approached the scandal from different points of view; and in 1896 a Select Committee of the House of Commons was appointed. No witness before a Select Committee has, it is believed, ever been subjected to such a prolonged course of petty ignorant spite and vexatiousness as Sir John Donnelly was. For months he had to undergo an almost daily crossfire of idle questions. However, the main upshot of the Committee's reports was a vote by Parliament of the handsome sum of 800,000*l*. to complete the permanent science and art buildings at South Kensington, thus securing the very object to obtain which Donnelly had laboured so hard. So far as concerned the relatively unimportant malicious statements and inaccuracies which were aimed at Sir John Donnelly in passages of the Committee's reports, the Lord President and Vice-President of the Council on Education issued a minute animadverting upon them and emphasising the fact that their lordships alone were responsible for the administration of the museums; their directions had been loyally carried out by the staff and they retained the fullest confidence in Sir John Donnelly and his colleagues. There can be little doubt now that the irritation to which the Select Committee's persistent attacks put Sir John told upon his health.

Sensitive and reserved, he had an almost over-exacting sense of rectitude. He did not court society —in the conventional sense—but preferred the exclusiveness of his own circle of friends, which included many men prominent in science and art. During his yearly holidays, chiefly spent in the quiet retirement of his house amongst the pine-woods at Felday, Surrey, he frequently sketched, and season after season one or two of his painstaking etchings and water-colour paintings were to be seen at either the Royal Academy or the New Gallery.

NOTES.

IT is too early to estimate fully the effect of the magnificent endowments provided for by the will of Mr. Cecil Rhodes, but we are all able to admire the noble conception which aims at promoting a good understanding between England, Germany and the United States. It would be difficult to suggest a better means of accomplishing this than that outlined by Mr. Rhodes. Students from our colonies, the United States and Germany are to be encouraged to spend three years in the University of Oxford, where they will become familiar with our national characteristics. Nothing but good can come from the friendships which will thus be founded; and there will be a strong influence tending to bring the three nations into close relationship with one another, which will enable political and commercial questions to be discussed without the distrust usually connected with them. Rarely have endowments been made with so lofty an object; and with such an example we look hopefully to the future for other ties to bind nations together. For the present, a brief statement of the provisions of the will as regards education will be sufficient to show the scheme by which this unity of race is to be furthered. Sixty scholarships of 300*l*. a year each are to be founded for colonial students. The scholarships will be tenable at any Oxford college for three consecutive years, and twenty are to be awarded every year, this number being distributed among the various portions of the British Empire. Two scholarships of the same value are allocated to each of the fifty States and Territories of the United States of America. Moreover, in recognition of the encouragement now given in German schools to the study of English, fifteen scholarships of the value of 250*l*. a year, tenable at Oxford by German students for three years, are to be established. The will thus provides for scholarships amounting to nearly 52,000*l*. per annum, which means a capital sum of from one and a half to two millions. Some of the scholarships would have been made tenable at Edinburgh if the University there had been on a residential system; for Mr. Rhodes mentioned in his will that fifty or more students from South Africa were studying there, many of them attracted by the excellent medical school, but the want of a residential system made him refrain from establishing any scholarships in connection with the University. Oxford, like Cambridge, has such a system, and the will suggests that "it should try to extend its scope so as if possible to make its medical school at least as good as that at the University of Edinburgh." The world will now look to Oxford to increase the value of its medical school, and we shall wait with interest to see what developments are made. Mr. Rhodes's old college at Oxford, Oriel College, receives 100,000*l*., of which 40,000*l*. is for the erection of new buildings, as a fund to cover the loss to College revenue involved in the removal of houses to make room for them; 40,000*l*. to endow an increase of income of resident fellows working "for the honour and dignity of the College"; 10,000*l*. to increase the comforts of the High Table, and the remaining 10,000*l*. is to be a fund for providing for the maintenance and repair of the College buildings. A sum yielding 2000*l*. a year is set apart for the cultivation of Mr. Rhodes's property at Inyanga, and he directs in particular that irrigation should be the first object kept in view. Other objects to be borne in mind are experimental farming, forestry, market and other gardening, fruit farming, and the teaching of any of those things, and the establishment and maintenance of an agricultural college. Mr. Rhodes's gifts are both bounteous in amount and grand in intention; and they reveal a greatness of character not often found.

MR. GEORGE WILSON, whose death was announced in our last issue, was one of those who early appreciated the immense importance of applying science to manufacturing industries. The results in his case were seen in the excellence of his products and in the importance of the incidental substances which were brought to light in the course of the manufacture. In his days the importance of scientific method and its superiority to rule of thumb were not so much insisted on as they are now. Mr. Wilson was not only a chemist, but an enthusiastic horticulturist, adopting gardening at first as a recreation, and of late years making it the occupation of his life. Although he published nothing but ephemeral notes on his favourite pursuit, he constantly insisted on the necessity of applying scientific principles to practical horticulture. In a very interesting little book entitled "The Old Days of Price's Patent Candle Company," in which the history of the manufactures which resulted in such vast improvements in candle making is detailed, he says: "Laboratory training teaches careful observation and close watching, both useful in gardening, which gives a wide field for experiment. If I read the future aright ten years hence good fruit will be much more general than it is now, and for one beautiful hardy plant now common in our gardens we shall have ten." This forecast was written in 1876, and it has certainly been fulfilled, if not quite in the way that Mr. Wilson had in his mind.

FOUR zoological lectures will be delivered in the meeting-room of the Zoological Society after the general meetings on April 17, May 22, June 19 and July 17. The subjects and lecturers are:—"Flying Reptiles," by Prof. H. G. Seeley, F.R.S.; "Horses and Zebras," by Prof. J. Cossar Ewart, F.R.S.; "The Okapi," by Prof. E. Ray Lankester, F.R.S.; and "Elephants," by Mr. F. E. Beddard, F.R.S.

Arrangements have now been made for the Nature-Study Exhibition to be held at the Gardens of the Royal Botanic Society, Regent's Park, on July 23 and following days. It will be open to colleges and schools of every grade, and the exhibits will include all that bears upon nature study. Various technical instruction committees and other educational authorities have already arranged to defray the cost of the conveyance of exhibits from their respective areas, and preliminary exhibitions for the purpose of selecting the best material to send are being organised in several districts. Full particulars may be obtained on application in writing to the hon. secretary, Nature-Study Exhibition, Royal Botanic Gardens, Regent's Park, London, N.W.

The annual general meeting of the Iron and Steel Institute will be held on May 7 and 8. At the opening meeting the Bessemer gold medal for 1902 will be presented to his Excellency F. A. Krupp, of Essen. Among the subjects to be brought before the meeting are:—The nomenclature of metallography; the microstructure of hardened steel; gas from wood for use in the manufacture of steel; the physical and chemical properties of carbon in the hearth of the blast-furnace; the sulphur contents of slags and other metallurgical products; and Brinell's researches on the influence of chemical composition on the soundness of steel ingots.

Sir Samuel Wilks, Bart., F.R.S., has been elected president of the Hampstead Scientific Society in succession to the late Sir Richard Temple.

The *Times* announces the death, at Munich, of the well-known bacteriologist Prof. Hans Büchner, in the fifty-second year of his age. Prof. Büchner, who was president of the Hygienic Institute at Munich, rendered important services to science in developing the modern theory of infectious diseases. From the same source we learn of the death, at the age of eighty-seven, of M. Emile-Jean Renou, founder, in 1873, of the Saint Maur Meteorological Observatory. In 1840 he was commissioned by the Government to explore Algeria, Morocco and Tripoli, and he drew up the first geological map of Algeria.

The *Chemical News* announces that the Fifth International Congress of Applied Chemistry will be held at Berlin during the Whitsuntide holidays in 1903, under the presidency of Dr. Clemens Winkler. The House of the Imperial Parliament (Reichstag) has been placed at the disposal of the Congress, and Geheimrath Prof. Otto N. Witt has been nominated president of the organising committee, Dr. Bottinger, member of the German Parliament, acting as treasurer. A fund of about 3000*l.* has already been collected by voluntary subscriptions from societies and private individuals towards the expenses of the Congress.

We learn from *Science* that at the February meeting of the council of the American Institute of Electrical Engineers a resolution, brought forward by the committee on standardisation, in favour of the metric system was unanimously adopted. The committee's report and resolution were as follows:—(1) The metric system of weights and measures offers very great advantages by its simplicity, consistency and convenience in every-day use, as well as in all engineering calculations and computations. (2) These advantages have already been demonstrated by the universal adoption and entirely successful use of the metric system in all civilised countries except Great Britain and the United States. (3) All the electrical units in universal use, such as the volt, ampere, ohm, watt, &c., are metric units. (4) The industrial use of these electrical units would be much facilitated by the general adoption of the metric system. (5) This committee unanimously recommends the introduction of the metric system into general use in the United States at as early a date as possible without undue hardship to the industrial interests involved. (6) The committee favours such legislation by Congress as shall secure the adoption of the metric system by each department of the National Government as speedily as may be consistent with the public welfare.

In a note contributed to the *Atti dei Lincei*, xi. 4, Signor C. Somigliana shows that Lord Kelvin's method of images can be applied to the solution of the equations of elasticity, under certain conditions, for solids with plane boundaries.

The Vienna *Sitzungsberichte* contains a note by Dr. Josef von Geitler on some experiments conducted for the purpose of proving the action of kathode rays on a magnetic needle. It now appears that a source of error has been discovered in the heating of the brass tubes employed, where the rays fall on them, and the consequent production of thermoelectric currents. Unfortunately, the direction of these currents is such as to deviate the magnet in the *same* direction as it would be deviated by the rays themselves. It appears only possible by means of quantitative measurements to ascertain whether any portion of the observed effect exists over and above what is directly attributable to the source of error in question.

The "red rain" which fell in many parts of Italy and extended as far as Vienna and other central European stations on the evening of March 10, 1901, has been subsequently studied by Prof. N. Passerini, and an account of the phenomena is now given by him in the *Bolletino mensuale* of the Italian Meteorological Society. The phenomenon appears to have travelled slowly from south to north, occurring at Palermo in the night of March 9-10 and at Florence in the night of March 10-11. Prof. Passerini found that the precipitation of the earthy substance was accompanied with very little rain, and a rough analysis showed it to contain about 44 per cent. of fine sand, 32 per cent. of argillaceous matter, 12 per cent. of calcareous matter and about 10 per cent. of organic and volatile substances destroyed by calcination. The red colour was probably due to ferric hydrate. In the samples found in Pisa and elsewhere, fragments of Diatomaceæ, as well as spores, are said to have been observed. It is suggested that the material deposited in this and other so-called "rains of blood" that have occurred at different times in Italy may probably have been transported by a cyclonic disturbance, and may have had its origin in the equatorial regions of Africa or America.

The "Results of Rain, River and Evaporation Observations" made in New South Wales during 1899 have been published by Mr. H. C. Russell, Government Astronomer, and contain, as usual, valuable observations for each month and tables showing the records for various stations since 1840. The number of observing stations has risen to 1724, the observers being mostly volunteers. The year 1899 is the fifth dry year in succession, the shortage of rain for the whole colony being 21 per cent., but in a large area west of the Darling the rainfall was from 16 to 67 per cent. below the average. Six good years, 1889 to 1894, had an average of 28·61 inches of rain, and five bad ones, 1895 to 1899 inclusive, had an average of 20·49 inches. Mr. Russell remarks that only the richness of the soil and the climate save the stock under such droughts, for even a shower will often give a good growth of grass and be in time to save the stock. The crops in 1899 were to a large extent saved, except in the western districts, by the rains which fell between June and October.

The Meteorological Service of Manila, which, under the superintendence of the Observatory at that place, has for many years published valuable annual summaries, has been reorganised on the lines of the United States Weather Bureau. From the beginning of the year 1901, the new Philippine Weather Bureau has issued monthly bulletins, containing data deduced

from hourly observations, with a chronicle of the weather in English and Spanish. The bulletin also includes accounts of unusual occurrences and notes on the crops obtained from stations established throughout the Archipelago. Among the occurrences is an account of the earthquake of December 15 last. This was the strongest shock experienced since 1880, and was felt over an area almost as large as Spain. It lasted for a minute and a half, but, owing especially to the slowness of the motions, the damage caused was not great.

THE *Annuaire Météorologique* for the present year, published by the Belgian Royal Observatory, under the direction of M. A. Lancaster, has been received. The annual is full of interest, and contains many useful facts and much accurate information on meteorological matters in general. Thus, after a short summary of the more important astronomical ephemerides, we find a meteorological calendar and the second portion of the history of meteorology in Belgium, covering the period from the foundation of the Brussels Academy of Science to the first publications of the Royal Observatory. M. Lancaster brings together all the facts relating to the temperature, rainfall and wind pressure at Brussels from the year 1833 to 1900, and prints, not only the monthly means or totals, as the case may be, but the mean value for each season and for the whole year. M. Vanderlinden writes a most interesting essay on the meteorological conditions of the upper atmosphere, and describes the various means that have been and are now adopted for exploring great heights meteorologically. A number of miscellaneous tables and data follow this article, and the annual concludes with an account of the movements of the atmosphere from cloud observations made at Brussels, a *résumé* of the meteorological observations made at Uccle, near Brussels, during the year 1901, and, lastly, a description of the climate of Belgium for the year 1900.

AN illustrated account of Mr. Wilbur Wright's aëronautical experiments with gliding machines is given in the *Scientific American* for February 22. These experiments differ from those of Messrs. Lilienthal, Pilcher and Chanute in two important features, (1) the horizontal position of the operator when gliding, which is calculated to save about half a horse-power by the diminution of air-resistance, and (2) the use of a front rudder instead of one at the back of the machine. In describing one of these experiments, made with a machine of 308 square feet in a wind blowing thirteen miles an hour, the *Scientific American* states:—The machine sailed off and made an undulating flight of a little more than 300 feet. To the onlookers this flight seemed very successful, but to the operator it was known that the full power of the rudder had been required to keep the machine from either running into the ground or rising so high as to lose all headway. The experiments also showed that one of the greatest dangers in machines with horizontal tails had been overcome by the use of a front rudder, and the operators escaped from positions which had proved very dangerous to preceding experimenters. In subsequent experiments the machine with its new curvature never failed to respond promptly to even small movements of the rudder. Many glides were made whenever the conditions were favourable.

THE Report of the Felsted School Scientific Society for 1900–1 contains an interesting account, by Mr. A. A. G. Dobson, of an expedition down the Bermejo River, organised by the Messrs. Leach, the well-known sugar- and coffee-planters of the Tucuman district of Argentina.

THE most important paper in the portion of the *Proceedings* of the Philadelphia Academy for 1901, which we have just received, is one by Miss C. B. Thompson on a new nemertean worm (*Zyguepolia littoralis*) recently discovered in Massachusetts. The account, which is illustrated by five plates, occupies eighty pages.

WE have received the second (April) number of a new monthly illustrated journal, *The Country*, published by J. M. Dent and Co. and edited by Mr. H. Roberts. In addition to ordinary subjects connected with the country, inclusive of sporting, farming and gardening, this number has three articles on natural history. One of these deals with wild life in Britain, as exemplified by the black-headed gull, the second treats of the songs of birds, from the point of view of systematic classification of the species, while the third describes bird-haunts. All three are well and pleasantly written, and the first and third are attractively illustrated.

MESSRS. BLACKWOOD have sent us a copy of the first number of a new journal, the *Field Naturalist's Quarterly*, edited by Dr. G. Leighton. The part, which is illustrated with a couple of excellent full-page photographic reproductions, opens with an account of certain uncommon British sea-fishes, by Mr. F. G. Aflalo, and contains thirteen other articles, four of which deal with animals and nature in winter. That the editor does not intend to confine his purview to British subjects is indicated by an anonymous article on the fauna of New Zealand; while the wide range proposed to be embraced is made evident by one on telegony in dogs, by Prof. Ewart. The appearance of this new journal may be taken as an earnest of the reviving interest in field natural history.

WE have received parts i. and ii. of vol. lxxi. of the *Zeitschrift für wissenschaft. Zoologie*. The former is entirely devoted to an elaborate memoir on the development of the kidneys in the amniote vertebrates, by Herr K. E. Schreiner, of the Anatomical Institute of the University of Prague. Important conclusions are drawn as to the relationship of the permanent to the primitive kidneys. Among the contents of the second part is a paper on the development of the Anatidæ, as represented by the domesticated duck, by Prof. P. Mitrophanow; while another, by Herr E. Botezat, deals with the nerves in the epithelium of the tongue of mammals. In a third communication, Herr F. Urban describes a new genus and species (*Rhabdodermella nuttingi*) of calcareous sponge from Monterey Bay, California.

THE issue of an annual report by the president of the Philadelphia Academy of Sciences, which has been in abeyance since 1881, has been resumed for the past year. In this Report Mr. S. G. Dixon gives a satisfactory account of the position and prospects of the Academy, the financial resources of which were largely increased in 1900. As in most institutions of a kindred nature, the attendance at the weekly meetings has, however, sensibly decreased owing to the increasing specialisation of natural history. An enormous increase has taken place of late years in the zoological collections of the Academy, the molluscan department having since 1887, when it was regarded as the leading collection in the world, received no less than 30,000 "lots."

IN the *Quarterly Journal of Microscopical Science* for March, Mr. E. S. Goodrich publishes the first part of a paper on the structure and homology of the renal organs of Amphioxus, or, as it should properly be called, Branchiostoma. The announcement of the author's important discovery as to the identity of these organs in their segmental arrangement, function and histological structure with the nephridea (renal organs) of polychætous worms like Phyllodoce has been already made in a preliminary paper, and the evidence is now submitted to the scientific world in fuller detail, accompanied by excellent illustrations. Bearing in mind that in both cases the renal organs are furnished with so-called "solenocytes," there seems, as the

author remarks, a strong probability that they are homologous. With characteristic caution, he prefers, however, to await an investigation into their developmental history before definitely stating that this is the case. Even the provisional identification of true nephridea in the vertebrate phylum is a most important advance in our knowledge. If this be confirmed by future investigation, it is not a necessary sequence that vertebrates are derived from the polychætous worms, all that is demonstrated being that the remote common ancestor of these now widely divergent branches was of a much more specialised type than has been commonly supposed.

THE authorities at the Royal Botanic Gardens have just published, as an appendix to the *Kew Bulletin*, a list of new garden plants which have been recorded during the past year. Only a few are actually in cultivation at Kew, but of these some will be available for distribution in the regular course of exchange. In the case of the remainder, reference is given, where possible, to the individual in whose garden or collection the plant was first brought to notice. One of the objects in publishing this list is to endeavour to ensure a uniform and correct naming of new plants.

MR. J. H. MAIDEN, in an extract from the *Agricultural Gazette* of New South Wales, directs attention to the practice adopted by the Australian aborigines of obtaining water from the roots of various plants in arid districts. The trees tapped for this purpose were species of Eucalyptus known as Mallee, and Hakea or Needlebush. Also some Casuarinas were known by the natives to store up water in their stems. The usual method of treating the roots was to cut them up into pieces about nine inches long; these might receive a preliminary chew, or without being subjected to that stimulus would be set on end in order to pour out their stock of water.

THE coal resources of India formed the subject of a paper lately read by Prof. W. R. Dunstan before the Society of Arts (*Journal*, March 21). He points out that India possesses a practically inexhaustible supply of coal, mainly of permo-Triassic age, and occupying an area estimated at about 35,000 square miles. The industry of coal-mining is at present in its infancy. During the year 1900 a little more than six million tons were produced, mainly from Bengal. The principal coalfields in that province are estimated to contain 136 million tons of coal. Excellent steam and coking coal occur in Bengal and also in Assam.

A SKETCH of the geology of the north-east coast of Labrador has been contributed by Mr. Reginald A. Daly (*Bull.* Mus. Comp. Zoology, Harvard Coll., vol. xxxviii., 1902). The foundation rocks of this coast consist mainly of a crystalline complex of schists and gneisses with intruded masses and dykes of granite, diorite and gabbro, with also slates and sandstones perhaps of Cambrian age. The general strike of the rocks, whether of cleavage or stratification, coincides with the trend of the coast; and in discussing this subject the author throws out the suggestion that the great Bank of Newfoundland may be a submerged mountain-plateau at the intersection of the Labrador and Appalachian structural axes. Attention was, however, mainly given to the glacial phenomena, to the general direction of ice-movements, the "lunoid furrows" described by Packard, and the post-Glacial movements as proved by raised beaches. The ice-movement at all elevations, both in the valleys and on the hill-tops, was found to have been outward from the central part of the peninsula. The "lunoid furrows" are crescent-shaped depressions five to fourteen inches broad by three to nine inches long, and about an inch deep vertically in the rock. Mr. Daly considers that they originate from the tension or shearing stress set up in the bed-rock by boulders dragged along beneath the ice, and that the actual hollows are due to the action of frost in post-Glacial times prizing up the fragments of disturbed rock. The limit of glaciation was about 2100 feet above the sea, so that the higher massifs formed nunataks overlooking the Pleistocene ice-sheet.

THE *Journal* of the Franklin Institute contains a long and elaborate paper on the Alasko-Canadian frontier, by Mr. Thomas Willing Balch. The historical evidence is carefully analysed, and there are reproductions of a number of old maps. The author concludes that the evidence shows overwhelmingly that the United States are entitled to an unbroken strip of land on the continent from Mount St. Elias down to the Portland Channel, and believes that they should never consent to refer the matter to arbitration.

WE have received from the author a copy of a pamphlet entitled "A Sketch of the Subject of Map Projections," by Major C. F. Close, R.E. A list of selected projections is given and a short explanation of the formulæ used in constructing each, also a list of examples and books of reference. The paper, which might well be expanded into the much-needed English text-book on the subject, will be extremely useful to anyone dealing with map projections. We note that the references contain no mention of the works of Tissot, Hammer or Zöppritz.

SEVERAL popular and instructive articles on scientific topics appear in this month's magazines. The frontispiece in *Pearson's Magazine* is a reproduction of a photograph of the head of a cobra, taken when the snake's head was only a yard away from the camera. Mr. S. S. Buckman describes and illustrates some characters and actions of babies similar to those exhibited by monkeys and suggesting a common origin. Dr. C. Brown gives a number of striking pictures of fossils of various kinds, and indicates the lessons taught by them. Stages in the opening of leaves of several plants are dealt with by Mr. G. Clarke Nuttall, and are pleasingly illustrated. A number of curves drawn with a compound pendulum accompany a description by Mr. A. Williams. In the *Royal Magazine*, Mr. W. M. Webb writes an account of a caterpillar farm at Scarborough, where moths and butterflies are reared as a business. The *Sunday Magazine* has several photo-micrographs of parts of caterpillars; and a number of "minute marvels of nature" are illustrated in *Good Words*, from photo-micrographs by Mr. J. J. Ward.

THE American Society for Plant Morphology and Physiology held their annual meeting at Columbia University under the presidency of Dr. Erwin F. Smith, of the Department of Agriculture. The president, besides delivering his address on plant pathology, presented a paper dealing with the destruction of cell walls by bacteria. Leaves of the turnip were inoculated with the bacterium *Pseudomonas campestris.* The disease appeared on the leaves and passed down to the root. Sections of the root showed the bacterial masses in the vessels and adjacent parenchyma. The bacteria grow in between the cells, dissolve first the middle lamella and then the rest of the cell walls, and finally occupy large cavities which have been formed by the destruction of large portions of tissue. Dr. C. O. Townsend described another bacterial disease occurring generally on the bulbs, sometimes on the roots or leaves of the Calla lily. At the same meeting, Dr. Harshberger suggested several lines of research which might be undertaken in the West Indies, and proposed that, owing to the suspicious nature of the Tahitians, a steamer should be fitted up as a research laboratory. Prof. Ganong discussed the teaching of plant physiology to large elementary classes. Dr. Margaret E. Ferguson gave an account of investigations into the condition of germination of Basidiomycetous spores, and Prof. Conway Macmillan described his observations on Pterygophora.

THE new volume of the "Statesman's Year Book," edited by Dr. J. Scott Keltie, with the assistance of Mr. I. P. A. Renwick, has been published by Messrs. Macmillan and Co., Ltd. This annual is now in its thirty-ninth year of publication, and every year brings political and other changes which necessitate the revision of much of the information contained in its pages. So far as it is possible for a volume to reflect the condition of the States of the world, the "Statesman's Year Book" performs that function most creditably. Nothing of importance in political geography is overlooked; and the shifting scenes, figures and activities are faithfully recorded. The volume for 1902 contains much revised material relating to the accession of King Edward VII., the census of Great Britain and of India, the development of our educational system, and colonial changes. The maps and diagrams show the results of recent censuses at home and abroad, existing and projected railways in East Central Africa, the new Indian province, and the projected Central America canals. The contents now occupy 1332 pages, and the volume should not be permitted to exceed this number very largely, or it will lose its handy character. How the editor will prevent the ultimate expansion of matter beyond the present limits of space is a problem to which he will need to give careful consideration.

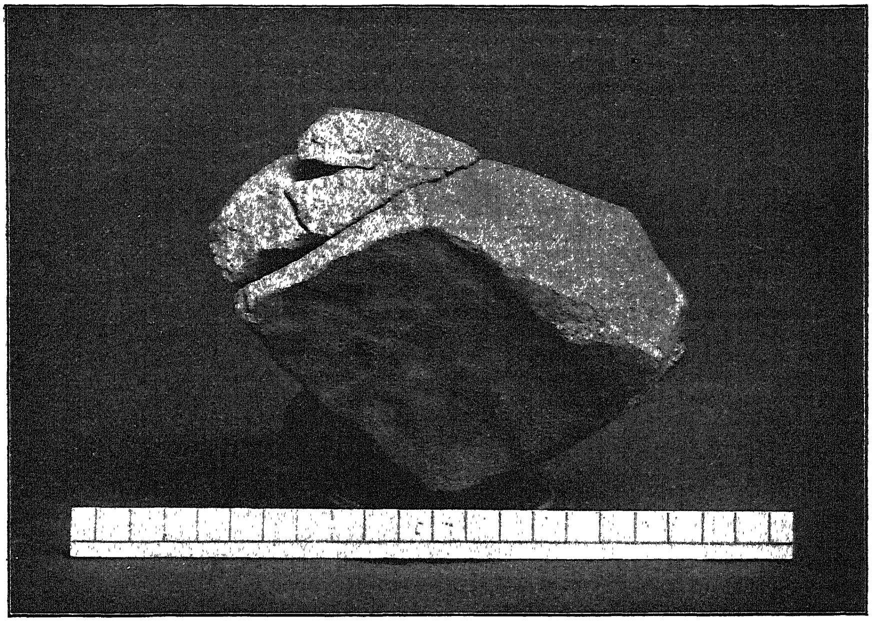
THREE new volumes of Ostwald's series of "Klassiker der exakten Wissenschaften" have been received from Mr. W. Englemann, of Leipzig. (London: Williams and Norgate.) The volume No. 119 (price 2*s.* 6*d.* net) contains two papers on hygrometry, by H. B. de Saussure (1783), edited by Dr. A. J. von Oettingen. The papers deal with the theory of evaporation and the application of the theory to some meteorological phenomena. No. 120 (price 3*s.* net) contains a German translation, with notes by Dr. M. Möbius, of two papers by Malpighi (1675 and 1679) on the anatomy of plants. Fifty figures illustrate the text, and the editorial notes will be of service to German students. Two papers on plant hybrids, by Gregor Mendel (1865 and 1869), edited by Dr. E. Tschermak, form No. 121 of the series. The price of this volume is 1*s.* net.

A NEW edition (the tenth) of Mr. W. T. Lynn's booklet on "Remarkable Comets" has been published by Messrs. Sampson Low, Marston and Co. The only comet expected to return this year is Swift's comet, having a period of 5½ years. This is due towards the end of the year.

THE additions to the Zoological Society's Gardens during the past week include two Black Apes (*Cynopithecus niger*) from the Celebes, presented by Miss A. T. M. Elliot; a Malayan Bear (*Ursus malayanus*) from Malacca, presented by the Marquis of Downshire; a Suricate (*Suricata tetradactyla*) from South Africa, presented by Mrs. Philips; a Golden-naped Amazon (*Chrysotis auripalliata*) from Central America, a Yellow-billed Amazon (*Chrysotis panamensis*) from Panama, seven Elegant Terrapins (*Chrysemys scripta elegans*) from North America, two Wrinkled Terrapins (*Chrysemys scripta rugosa*) from the West Indies, deposited; six Ruffs (*Machetes pugnax*), four Snow Buntings (*Plectrophenax nivalis*) European, eight Undulated Grass Parrakeets (*Melopsittacus undulatus*) from Australia, purchased: an Eland (*Orias canna*) born in the Gardens.

OUR ASTRONOMICAL COLUMN.

THE FELIX METEORITE.—In a recent number of the *Proceedings* of the United States National Museum, Mr. G. P. Merrill gives an account of the fall of a meteoric stone at 11.30 a.m. on May 15, 1900, near Felix, Alabama. A luminous meteor was seen and three loud reports as of explosion were heard. The main mass weighed about 7 lbs. and was found buried six inches deep in soft ground. In aspect of fractured surface the material is like that of the stones of Warrenton and Lancé, but the chondritic character is more pronounced than in the latter and the colour is darker than in the former, owing to the presence of graphitic carbon in appreciable quantity. The essential minerals are, olivine (73 per cent.), augite and enstatite (18 per cent.), with troilite (5 per cent.), nickel-iron (3 per cent.) and graphitic carbon (0.4 per cent.): the micro-structure is tuff-like.



The Felix Meteorite. The scale below the meteorite is divided into centimetres.

ON THE RELATION BETWEEN INTELLIGENCE AND THE SIZE AND SHAPE OF THE HEAD.

THERE is a popular belief that men of great ability have larger heads than the average population; this belief, however, is not based on trustworthy statistics handled in a satisfactory manner.

In a paper read before the Royal Society, January 23, Prof. Pearson gives the results of statistical investigations undertaken with a view to determine whether any head measurements, and if so, which, are correlated with intellectual capacity.

He points out that although the professional classes are more intellectual and have a larger mean head capacity than the hand-working classes, this does not lend any support to the current notion; for the former are better developed physically, and the difference is probably only due to difference of nurture. It is necessary to take a homogeneous class in order to investigate the matter.

The Cambridge Anthropometric Committee furnished a series of measurements made on Cambridge undergraduates, and information was obtained from the University Registry of the degree (honours or poll, class-place, subject, &c.) taken by each of the individuals whose measurements were given.

The undergraduates furnish a homogeneous class of the same general habits.

They were divided into two groups—honours and poll men—and fourfold tables were made for:—

(1) Cephalic index and degree; (2) length of head and degree; (3) breadth of head and degree.

The table for (1) will illustrate the method in which all the tables were made.

Cephalic Index.

		Under 80.	Over 80.	Total.
Ability	Honours ...	307·5	216·5	524
	Pass	276·5	210·5	487
	Total.........	584	427	1011

The tables were worked by the method given in Prof. Pearson's memoir "On the Correlation of Characters not Quantitatively Measurable" (*Phil. Trans.*, vol. cxcv. A., pp. 1–47).

The divisions taken for length were under 7″·65 and over 7″·65, and for breadth over 6″·05 and under 6″·05. The correlation between ability and dolichocephaly was found to be ·0305 ± ·0349; between ability and long heads ·0861 ± ·0332; between ability and broad heads ·0450 ± ·0322.

If the numbers here given were of sensible magnitude, they would lead to the conclusion that ability is directly correlated with increased length and with increased breadth of the head and also with dolichocephaly. But on a comparison of the numbers with their probable errors it is seen that the correlation has no significance in the cases of cephalic index and of breadth; in the case of length, the correlation is between two and three times the probable error, but it is in itself too small to be of any real importance.

The Cambridge results may consequently be taken to show that there is no marked correlation between ability, as judged by entry for an honours examination, and the size or the shape of the head.

The problem was next worked out from a series of measurements made in schools. The data here are less satisfactory, for the measurements were made in schools of all grades all over the country, and consequently give a mixture of classes and of ages.

The cephalic index remains practically constant during growth; children of all ages may therefore be put together in this measurement; the length and the breadth of the head change with age, and the measurements in these cases must be reduced to the same age.

This was done by forming tables of correlation between length of head and age, and between breadth of head and age.

1856 boys were taken of ages running from four to nineteen years; the mean length was found for each year of age and a curve obtained of the average length of head of boys from four to nineteen years of age.

This curve showed apparently a period of rest in growth during the twelfth year. (A similar but less-marked rest in the twelfth year is also shown by T. W. Porter's curves for growth of head of St. Louis boys.)

The twelfth year was consequently chosen as the standard age to which all the measurements were reduced. The growth of the average boy for every year of age was then found. These values were added to the lengths for boys under twelve and subtracted from the lengths for boys over twelve. This gives what would be the length of head at twelve under the assumption that each boy grows like the average boy; this is, of course, not actually the case, but for a broad classification will hardly lead to serious error.

The same method was applied to the measurements on the breadth of head.

The children were arranged by their schoolmasters into the following classes:—

Quick-Intelligent, Intelligent, Slow-Intelligent, Slow, Slow-Dull, Very Dull.

In forming the correlation tables for ability and head-measurements, Quick-Intelligent and Intelligent were placed in one class and all the rest into a second class, called respectively Intelligent and Slow.

The divisions for cephalic index were taken as under 78·5, over 78·5; for length of head (reduced to twelfth year) below 184·5 mm., above 184·5 mm.; and for breadth of head (reduced to twelfth year) below 145 mm., above 145 mm. The results found were:—

Correlation between ability and dolichocephaly = ·0052 ± ·0240
Correlation between ability and long heads = ·0437 ± ·0242
Correlation between ability and broad heads = ·0843 ± ·0240

The results are in complete agreement with the Cambridge results.

The Cambridge and the school results taken together give practically a (mean) correlation of ·065 between size of head and ability. This value was taken and the class of people considered who have an ability so great as only to occur in 2 per cent. of the population—a fairly high standard. This was worked out by the tables of the probability integral, and it was found that 44 per cent. of the population have heads as large or larger than the mean head of the exceptional 2 per cent. of the population. Conversely, 44 per cent. of the population are as able or abler than the 2 per cent. of the population with exceptionally big heads.

But as 50 per cent. of the population are abler or larger-headed than the mean of the population, the above result shows the smallness of the basis upon which the argument from ability to largeness of head, or *vice versâ*, depends.

The Cambridge statistics were then investigated in the following manner. The honours men were divided into the three classes taken in examination. Two tables were made; in the first table, first- and second-class men were put in one division and third-class men in another, and a fourfold table was made with cephalic index. The correlation between ability and dolichocephaly came out = ·0641 ± ·0487. In the second table, the first-class men were taken alone for one division, and the second- and third-class men formed the second division; the correlation was found to be = − ·0254 ± ·0490. The numbers in both cases are non-significant; there is no evidence to show that ability as tested by examination is related to shape of head.

Corresponding tables were made for length of head and for breadth of head. The results were:—

Length (first and second classes together) ...	correlation = ·0865 ± ·0471
Length (second and third classes together) ...	correlation = ·1263 ± ·0439
Breadth (first and second classes together) ...	correlation = ·0056 ± ·0475
Breadth (second and third classes together) ...	correlation = ·1689 ± ·0478

These results seem to show an increasing correlation between ability and size of head when the first-class men are separated from the rest, but it seems possible to attribute the divergence of the results to other causes. Length and breadth of head increase with age, and here, on the whole, the honours men are older than the poll men and the first-class men than the second, for a considerable number of resident dons were included in the measurements of the honours classes.

Of course the scale of intellectual ability must always be a vague one. A man is reputed to be "able" by his contemporaries, but future ages may rate him as of small importance. All we can do is to take a more or less popular appreciation. The examiner's test is not a perfectly satisfactory one, but it is idle to suppose that *on the average* it does not distinguish between the able and the dull. The same may be said of the teacher's estimate; it is far from absolutely correct, but it is reasonable *on the average* and better than the examiner's. Lastly, we have the youth's own opinion of his capacity, as judged by the reading for a poll or honours degree. Tried by all these three tests, there is in the general population very insignificant correlation between ability and either the size or shape of the head. Very brilliant men may have a slightly larger head than the average, but the increase is so small that no weight can be laid on it in our judgment of ability.

THE EXPLORATION OF THE ATMOSPHERE AT SEA BY MEANS OF KITES.

FOR some years past, kites have been persistently and successfully employed by Mr. A. L. Rotch at his observatory at Blue Hill, U.S.A., for obtaining a knowledge of the movements, temperature and humidity of the upper air, and heights of three miles have been reached; their use was also systematically begun about the same time on the continent of Europe, especially at M. Teisserenc de Bort's observatory at Trappes, near Paris, where altitudes exceeding those at Blue Hill have been attained. We have also frequently referred to similar experiments both with kites and balloons made at the request of the International Aëronautical Committee. Valuable results have been obtained and published, so far as the land is concerned, and experiments will, we believe, be undertaken in this country under the superintendence of the Royal Meteorological Society. But in order to raise the kites to any considerable height, a wind of certain velocity is necessary. Mr. Rotch's flights were made when the wind velocity on the ground was between twelve and thirty-five miles per hour, and he points out that certain types of weather, such as anti-cyclonic conditions, with very light winds, or stormy conditions, can rarely be studied by that means.

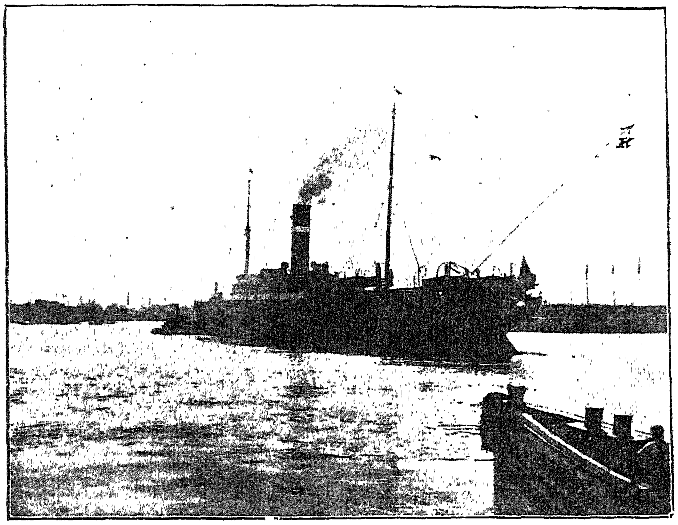


FIG. 1.—S.S. *Commonwealth* leaving Boston (kites were flown from K).

The prediction of weather for a day or so in advance has been brought to considerable perfection by the combined efforts of various meteorological services and the publication and study of synoptic weather charts; but further progress is necessary, and we believe that it is to the investigation of the upper air, especially if, as has been suggested, observations could be carried out in equatorial and trade-wind regions, where the changeable conditions of our latitudes do not exist, that further advance in weather knowledge may be confidently expected.

The plan proposed in a paper recently communicated to the Royal Meteorological Society by Mr. Rotch, and published in its *Quarterly Journal* for January last, with reference to the extension of kite observations to the sea, will doubtless lead to important results, and such observations will show whether the conditions prevailing over the ocean differ materially from those existing over the land. We give illustrations of Mr. Rotch's endeavour to obtain data with kites sent up from the s.s. *Commonwealth* while crossing the Atlantic, through the courtesy of Captain J. McAuley. Fig. 1 shows the vessel leaving Boston on August 28, 1901, and the position from which the kites were flown, while Fig. 2 shows the installation of the kite-reel on the after-deck of the vessel.

The kites can be used on ships to better advantage than on land. For example, even when the air is calm, by steaming through it at a speed of ten or twelve knots the kites can be raised to the height they would reach in the most favourable natural wind, and attain the altitude of the upper air-currents. During the passage of the *Commonwealth*, anticyclonic conditions mostly prevailed, and the wind blew only four to twelve miles an hour; but as the vessel steamed about fifteen knots, it was possible to use the kites on five days out of eight occupied in crossing the Atlantic. In one of the flights it was found that the air was 5°·6 warmer at a height of 130 metres than it was at the sea-level, and remained so during the afternoon (August 31). Another advantage gained by flying kites from a steamship is that wherever the observations in the upper air may be made there is always the observing station on the ship at sea-level, and not far distant, horizontally, with which to compare them.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

THE Technical Instruction Committee of the City of Liverpool is the recognised local authority through which the Board of Education deals with all the science and art classes in the city with only two exceptions. The Committee carries on its work through many agencies in an organised plan, and every year several important developments are recorded. From the Report for the year 1901 we learn that the committee again renewed the grant of 200*l*. in aid of the scientific work carried on by the Lancashire Sea Fisheries Joint Committee. A permanent sea fisheries laboratory in the zoological department of University College, under the direction of Prof. Herdman, is partly supported by this grant; and trained assistants are constantly at work in this laboratory, investigating fisheries' questions that may arise in connection with the local industries. One of the rooms of the zoological museum at University College is devoted to a permanent fisheries collection, illustrating the local fishing industries, but no part of the grant made by the Technical Instruction Committee is expended on this museum. In connection with courses of lectures to gardeners on plant diseases, given by Prof. Harvey Gibson, a course of special lectures, followed by practical work in the botanical laboratory, has been arranged in the new Hartley Botanical Laboratory at University College. This attempt to show practical working gardeners the scientific methods of

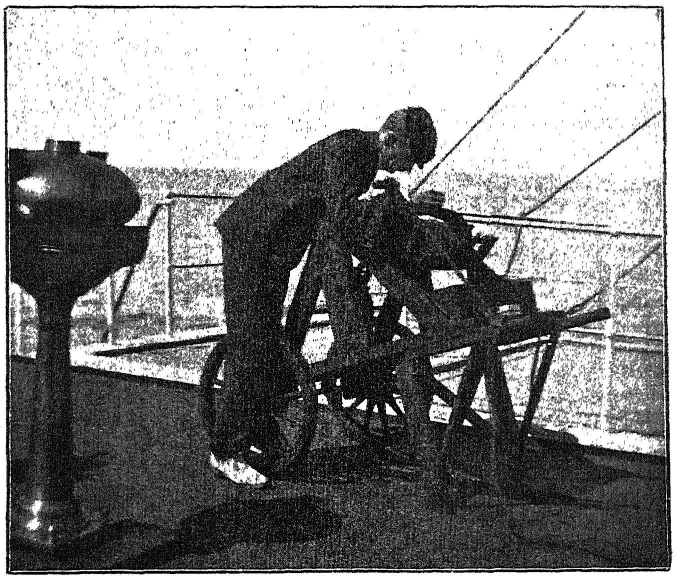


FIG. 2.—Kite-reel on after-deck of s.s. *Commonwealth*.

observation and investigation into such problems as those of plant disease is likely to be of the greatest value.

THE Report of the Technical Education Committee of the Derbyshire County Council states that the Technical School at Glossop, erected by Lord Howard of Glossop, has during the past year been furnished and equipped by the Glossop Town Council, aided by a grant of 600*l.* (in addition to the loan of chemical and physical apparatus) from the County Council. There are now nine schools of science in the administrative county, of which seven are co-educational schools for boys and girls. It is sometimes complained that the "school of science" curriculum is not sufficiently commercial, but early specialisation in purely commercial subjects, such as bookkeeping, commercial geography and business letter writing, should certainly not be encouraged. The Committee quotes in this connection Mr. Sydney Webb's remarks that "English business is not being driven to the wall because of a dearth of qualified clerks and trained office boys. . . . What we have to do is to train our business men, be they clerks or partners, not merely or even chiefly to discharge their office routine, but to let their intellects play round their business, to put into their work, not only brains, but brains of the highest or inventive kind. This is where they seem at present to fall behind the German and the American. Now we may take it for granted that we cannot get business men of wider minds by narrowing their education, nor produce that heightening of the imagination which makes discoveries by carefully shutting out all knowledge of the world that is not business. The most efficient business man, in this highest sense of the word efficient, will, we may be sure, not be an uncultivated man nor a man of narrow range."

SCIENTIFIC SERIALS.

Bulletin of the American Mathematical Society, February.—Prof. F. N. Cole is the chronicler of the proceedings at the eighth annual meeting, in New York City, of the Society on December 27, 28, 1901. Though now two days are devoted to the conference, owing to the large number of papers sent in (twenty-seven), this time is hardly adequate, and it is becoming a serious question whether it will not be necessary to adopt a practice of selection, permitting the presentation, even then in condensed form, of more important papers only. The meeting was largely attended, the number of members present amounting to fifty-nine. A social feature was the dinner on the Friday evening. The officers and members of council were elected. Sir Robert Ball was present, and amongst the abstracts of the papers communicated is that of his recent researches in the theory of screws. Miss Scott's paper on a recent method for treating the intersections of plane curves investigates the nature of the set of equations discussed in Dr. F. S. Macaulay's paper in the London Mathematical Society's *Proceedings*, vol. xxxi., giving different and simpler proofs of the theorems obtained by Dr. Macaulay.—Prof. Holgate gives an account of the proceedings at the January meeting of the Chicago section, held at Evanston, Illinois, January 2, 3, 1902. Here also the attendance was unusually large. Nineteen papers were presented, and abstracts of them are here given. "The Vector Analysis" of Dr. E. B. Wilson is reviewed by Prof. A. Ziwet. Prof. Gibbs's "Elements of Vector Analysis" (1881–4) attracted wide attention, though it was only a pamphlet (83 pp.) printed for the use of his students. This Mr. O. Heaviside adopted, with slight modifications, and expounded fully in his "Electromagnetic Theory" (1893). Dr. Wilson's work is founded upon Prof. Gibbs's course of lectures delivered in 1899–1900, and gives the first generally accessible authentic record of Prof. Gibbs's system. The additions to the theory of the (1881–4) pamphlet are not extensive, though Dr. Wilson's book runs into 436 pp. This bulkiness is due to the lavishly open print and partly to the author's effort to make the subject easily intelligible by supplying numerous illustrations and applications. A good index is a desideratum, and the printing details lack the advantage of external aids now so common in carefully printed mathematical text-books.—Mr. J. L. Coolidge gives an interesting notice of Dr. Max Simon's "Euclid und die sechs planimetrischen Bücher" and of Prof. M. J. M. Hill's "The Contents of the Fifth and Sixth Books of Euclid."—The notes and new publications give the usual interesting information.

Memoirs (*Trudy*) *of the Kazan Society of Naturalists*, vol. xxxiii., 5 and 6.—Researches into the soils and flora of the Penza and Gorodische districts, by J. Sprigin.—On the Erinaceæ of Russia, by K. Satunin (with one plate). The following five species, found in European Russia, Caucasia and Transcaspian territory, are described:—*Erinaceus europaeus*, *E. auritus*, *E. albulus*, *E. macracanthus* and *E. hypomelas*.

Vol. xxxiv.—This volume is dedicated by the Society to the professor of geology, Alexander Antonovitch Stuckenberg, whose portrait is given.—The Plagioclase-augite rocks between the Yenisei and the Lena, by A. Laversky. A large collection of 350 specimens of these rocks was made thirty years ago by Czekanowski and is now described, the author giving also a general geological review of the region. Cambrian and Silurian deposits constitute the frame of the plateaus. They are covered with coal-bearing, brown Jurassic deposits (perhaps also Miocene), and the latter are pierced and covered with basalts, breccias and volcanic tuffs, which in their turn are occasionally covered with post-Pliocene deposits. The sheets of basalt seem to have been ejected immediately after the deposition of the coal-bearing sandstones, and cover an immense space—larger than anywhere else on the globe—and are similar to the basalt sheets of Novaya Zemlya, Franz Josef Land, Greenland, Jan Mayen, Iceland and the north-western portion of Great Britain. A map and several plates, as also a summary in French, accompany this excellent and very elaborate work.—Materials for the fauna of the Devonian deposits of the Urals, by P. Kazansky, with one plate (summed up in German).—Materials for the knowledge of the soils and the vegetation of Western Siberia, by A. Gordyaghin, part i. Under this modest name the author gives, as an introductory chapter, an excellent description, geographical, geological and botanical, of the region in the basin of the Irtysh (from 49° to 61° N. lat.), where we see the gradual transition from the black-earth steppes to the forest region. Some very interesting discussions about desiccation and the periodical changes in the precipitation in Western Siberia are incorporated in this chapter.—On the Turbellariæ of the Solovetsk Islands, by I. P. Zabusoff. Descriptions of the thirty-nine species, some of which are new, which were found in this part of the White Sea, and anatomical descriptions of four especially interesting forms (long summary in German, and three large plates).—The fauna of the Carboniferous limestone on Shartymka River, on the eastern slope of the Urals, by M. Ianishevsky (seven plates and one map). No less than 328 different species, some of which are new, are described, and the conclusion is that these limestones (described already by Verneuil and Murchison) seem to belong to the Lower Carboniferous age.—First addition to the "Fauna of the Permian Deposits of Eastern European Russia," by A. Netchayeff, with three plates. Eighteen species, of which nine are new, are described in Russian and in German.

Bulletin de l'Académie des Sciences de St. Pétersbourg, 5e série, tome xi., 1–5.—Observations of minor planets, made at Pulkova with the 15-inch refractor in 1898 and 1899, by W. Séraphimoff. The positions of thirty-five minor planets are given.—Observations of terrestrial magnetism at Obdorsk and Samarovo (North Siberia), by H. Abels.—On the products of oxidation of the new alkaloid cotarnine, by G. Wulff.—On the determination of the form of the solar disc, by W. Ceraski.—Actinometric measurements at Ekaterinburg, by P. Müller.—Determination of the velocity and direction of motion of clouds, by V. Kouznetsov (according to Pomortseff's method), with a plate.—Researches into the coefficient of refraction of ethyl ether in the vicinity of the critical point, by Prince B. Galitzin and J. Wilip (in German). The chief results of this elaborate work are: the critical temperature is 193°·61 C.; critical pressure, 36·28 atm.; critical volume, 3·84 c.c. The formula of Lorentz represents very well the relations between the refraction-coefficient and the volume, and covers a wide range of temperatures (10° to 100°), both for the liquid and the gaseous states. The Lorentz constant is $C = 0·3025$. "It must also be admitted that in certain circumstances the liquid state may persist above the critical point—a phenomenon which is quite analogous to the retardation of evaporation."—Contributions for explaining various information from oriental sources about Eastern Europe, by F. Westberg. A learned and very interesting series of researches about the information found in these sources about different nations—the Rûs, the Madjars, the Vyes, and so on.—On the classification of the Chrysomonades, by L. Iwanoff (in German). Certain peculiarities of structure

of the genus Mallomonas permit the author to establish a classification of this difficult division.—A new archaic inscription of the Roman forum, by A. Enmann.

Bulletin du Jardin Botanique de St. Pétersbourg, tome ii. fasc. i.—On the causes of the absence of wood on the *yailas* (high mountain plateaus) of Crimea, by G. J. Tanfiljew. The cause is probably in the late thawing of snow—often in May only—and the consequent saturation of the soil with water.—Lichenological notes, by A. A. Elenkin. – Communications.

Memoirs of the Novorossian (Odessa) Society of Naturalists, vol. xxiii., 2.—Remarks on the Crimean stag, by A. Brauner (two plates). Unlike Ward, Nikolsky and Lydekker, the author considers this stag as *C. elaphus*, L., which is near, not to the typical individuals from the forests, rich in food, of middle Europe, but to the island type (also mountain and southern type), and especially to the Corsican representative of this species (summary in German).—On the nitrification of water, by E. Gredig.—Note on the Sarmatian deposits of Transcaucasia, by V. Lashkarev, on the basis of Prof. Ernest Favre's collection at Geneva.—Fauna of the caves of Crimea, by J. Lebedinski, with one plate. First attempt to explore these caves.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, November 28, 1901.—"Micro-crystalline Structure of Platinum." By Thomas Andrews, F.R.S.

The crystalline structure of platinum does not appear to have been studied, although it forms an interesting subject for investigation. A small ingot of pure platinum was obtained for the experiments. A section was cut therefrom and machined to 5/16th inch square and 1/10th inch in thickness. The section

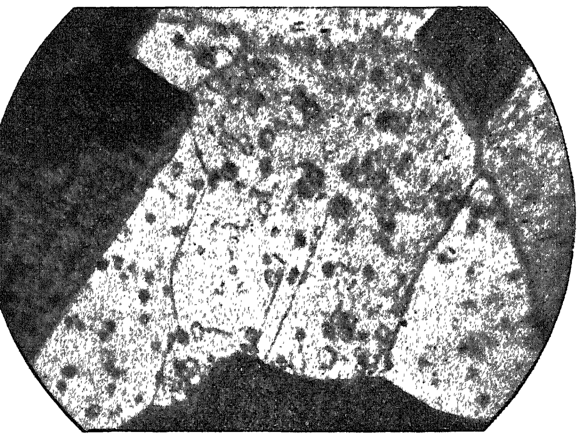


FIG. 1.—Micro-crystalline structure of platinum as seen in section at 360 diameters.

was then carefully polished and etched in aqua regia. The etching was very difficult and required the greatest care in manipulation to satisfactorily develop the crystalline structure. The result of the etching was the development of a beautiful crystalline structure which manifested, not only the large or primary crystal grains, but also the secondary or very minute crystalline development which is illustrated on a plate accompanying the paper, as seen in section at magnifications respectively of 50, 120, 360 and 360 diams. The last two of these figures are here reproduced. The larger or primary crystal grains were observed to consist of irregular polygons of varying size, the etched indications of the facet junctions being often clearly and sharply defined. The minute or secondary crystals (whose intercrystalline junctions were also clearly seen) were in the mass observed to be in varied positions of orientation, but the orientation was generally identical, or on the same plane, within the area of each larger crystal grain. The general orientation of the smaller crystals varied, however, in each separate larger crystal, and the consequent varied reflection of the light has given the face of the microsections, as a whole, the appearance of lighter or darker areas in the photomicrographs. In some portions of the mass there were observed minute triangular crystals; these appear, however, to be only developments resulting from the cutting of certain crystals in section. The general microcrystalline structure of platinum was observed to be allotriomorphic in character

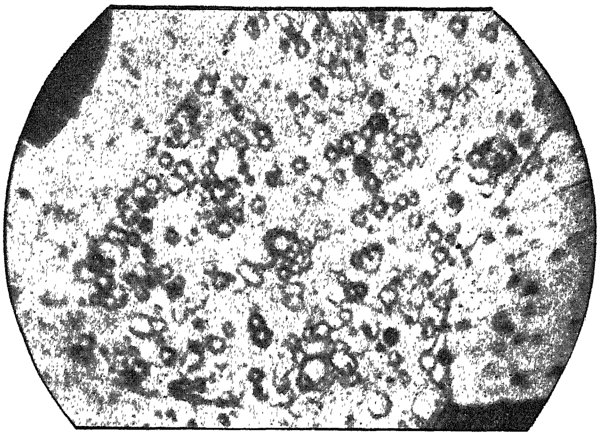


FIG. 2.—Micro-crystalline structure of platinum as seen in section at 360 diameters.

and derived from a system of interfering cubes and octahedra, the cubic and hexagonal form being frequently noticeable. The size of the large crystal grains varied from about 0·002 inch to 0·04 inch in size, and the smaller crystals ranged from about 0·0002 inch to about 0·007 inch. There were indications that the smaller or secondary crystals were each built up of even more minute crystalline ramifications. The crystalline structure of platinum appears to generally resemble that of gold and silver. The descriptive words "primary" and "secondary" crystals are only used in relation to size, and they are not intended to convey the idea of distinctive times of formation during solidification.

February 13.—"Preliminary Note on a Method of Calculating Solubilities and the Equilibrium Constants of Chemical Reactions, and on a Formula for the Latent Heats of Vaporisation." By Alexander Findlay, M.A., B.Sc., Ph.D. Communicated by Prof. Ramsay, F.R.S.

If R and R′ represent the ratios of the absolute temperatures at which two substances have the same solubility, the author shows that $R = R' + c(t' - t)$, where c is a constant having a small positive or negative value and t' and t are the temperatures at which one of the substances has the two values of the solubility in question. The formula is precisely similar to that which Ramsay and Young showed to hold in the case of vapour pressures (*Phil. Mag.*, 1886, xxi. 33). Given the solubility curve of one substance it is therefore possible to calculate the solubility of a second substance provided the solubility of the latter at two temperatures is known. The author shows that this method can be applied to the calculation of "equilibrium constants" of chemical reactions.

It is further shown that if L_1 is the known latent heat of vaporisation at the absolute temperature T_1 of one substance, and L_2 the latent heat of the second substance at the temperature T_2 at which the vapour pressure of the second substance is equal to that of the first at the temperature T_1, then $L_1/L_2 = T_1^{x_1}/T_2^{x_2}$. A less exact, but simpler formula is $L_1 = L_2 T_2^x$. These formulæ appear not to be applicable when the pressure exceeds 10,000–20,000 mm.

February 20.—"On a Pair of Ciliated Grooves in the Brain of the Ammocœte, apparently serving to promote the Circulation of the Fluid in the Brain-cavity." By Arthur Dendy, D.Sc., F.L.S., Professor of Biology in the Canterbury College, University of New Zealand. Communicated by Prof. G. B. Howes, F.R.S.

The author demonstrates the existence in the brain of the Ammocœte of a pair of remarkable ciliated grooves. The structures in question were discovered by the author in the

Ammocœte of *Geotria australis*, the New Zealand lamprey, and subsequently he found similar organs in sections of an Ammocœte of *Petromyzon* in the zoological laboratory of Owens College. The grooves in question run along the roof of the brain-cavity from about the hinder margin of the posterior commissure to the *recessus subpinealis*. They are lined by a sharply defined epithelium of very long columnar cells, and their concave surfaces are covered with short cilia. The function of these organs is apparently to promote the circulation of the fluid in the brain-cavity, and this view is supported by the arrangement of the choroid plexuses. In the New Zealand Ammocœte the choroid plexus of the mid-brain dips down into the *iter* in the shape of a highly vascular longitudinal septum dividing the upper part of the brain-cavity in this region into right and left halves, and it is significant that the ciliated grooves are so arranged as probably to direct a stream of brain-fluid along each side of the septum. It has been already suggested that the choroid plexuses of the vertebrate brain are concerned with the gaseous interchanges which take place in the cavities of the ventricles. In the young Ammocœte the first choroid plexus, which may be supposed to be especially concerned in the respiration of the fore-brain, is not yet developed; the second and third choroid plexuses, belonging respectively to the mid- and hind-brain, are, on the other hand, already extensive. We need not, therefore, be surprised to find that the fore-brain at this stage is dependent to a large extent for its means of respiration, and perhaps also for its nutrition, upon the choroid plexus of the mid-brain, and that a special apparatus in the form of ciliated grooves is developed for securing a forward flow of the necessary fluid in the brain-cavity.

March 20.—"On the Development of the Layers of the Retina in the Chick after the Formation of the Optic Cup." By John Cameron, M.B., Ch.B. (Edin.) Communicated by Prof. Macintosh, F.R.S.

The inner wall of the retinal cup in a fourth-day chick has exactly the same structure as the wall of the embryonic cerebral vesicle or spinal cord at the same date. All the structures which His has described in the wall of the embryonic spinal cord can be also recognised here, and may, therefore, receive similar names—thus, there is a network (the myelospongium) which is formed by spongioblasts, and between the fibres of the myelospongium are found germinal cells which divide to form neuroblasts. From the latter are formed the cells of the outer and inner nuclear layers and the ganglion cells of the retina. On the eighth day the internal molecular layer appears, and on the ninth day the external molecular layer. The first appearance of these layers is due to a rearrangement of the myelospongium, and they map out the three cellular layers. Three kinds of cells are found in the internal nuclear layer at the twelfth day—amacrine, bipolar and basal cells. The cells of the external nuclear layer become rod and cone cells, and from them rods and cones begin to develop on the twelfth day of incubation. The hexagonal pigment cells develop from the outer wall of the retinal cup, and their processes also appear on the twelfth day.

Linnean Society, March 6.—Mr. Herbert Druce in the chair, succeeded by Mr. A. D. Michael.—Mr. J. E. Harting exhibited and made remarks upon some unpublished coloured drawings by Messrs. J. G. Millais and A. Thorburn of British freshwater Anatidæ illustrating intermediate phases of plumage, through and irrespective of moulting, not hitherto figured.—A paper by Prof. A. Gruvel, of Bordeaux, was read, dealing with some cirrhipedes preserved in the British Museum of Natural History. The chief feature of the paper was the introduction of several new families into the group Lepadidæ as accepted by Darwin, and modified by Gerstäcker by the separation from it of the Alcippidæ for a single species.—The zoological secretary gave an abstract of a memoir by Prof. Elliott Smith, of Cairo, "On the morphology of the brain in the mammalia, with especial reference to that of the lemurs, recent and extinct." The author has examined either the brain or cast of the brain-cavity of every lemuroid genus living and extinct, and his work is the result of an investigation of the collections of the Royal College of Surgeons Museum, the British Museum, the Zoological Society, aided by gifts of material by Captain Stanley Flower, Mr. Hose, and other persons named. A critical *résumé* of the literature of the subject is followed by a detailed consideration of the sulci, the calcarine and sylvian fissures receiving special attention. The author shows that the simplest lemuroid type of brain is that of the Galaginæ, the most specialised that of the Indrisinæ and Lorisinæ. He shows that in Cheiromys the individual variation of the sulci is so great that the suprasylvian and lateral fissures alone remain unchanged, and he finds proof in this genus of ontogenetic retrogression, which substantiates the conclusions of Forsyth-Major originally deduced from the study of the living Galaginæ, the Tertiary genus Microchœrus, and more recently from that of the Madagascar genera Globilemur and Megaladapis. For Tarsius he shows, while the brain, in respect to its occipital overlap and the presence of a posterior cornu, as also to the assumption of the microsmatic condition, is the most pithecoid of that of all lemurs; conversely, in the characters of its corpus callosum, hippocampus and cerebellum, it is shown to conform to the lowest Eutherian type. Regarding Tarsius as a lemur, the author concludes that the lemuroid brain is intelligible only on the supposition that it has advanced along the main primate stem and later undergone retrogression. A caudo-occipital curtailment of the hemisphere is regarded as the dominant change which the lemuroid brain has undergone, with accompanying structural simplification; and evidence is adduced to prove that while the lemuroids were ancestrally macrosmatic, the macrosmatic condition at present found to exist in them has been secondarily acquired from a pithecoid microsmatic state, of the order of that retained in the tarsier. Beyond this, the memoir deals exhaustively with the comparative morphology of the pallium of the chief mammalian orders, with especial reference to confusion of ideas concerning fissures to which the term "sylvian" has been applied.

March 20.—Prof. S. H. Vines, F.R.S., president, in the chair.—Prof. J. C. Bose read a paper on electric response in ordinary plants under mechanical stimulus. He first explained his apparatus and methods, and then performed, with the aid of his assistant, a series of experiments showing electric response for certain portions of the plant organism, which proved that as concerning fatigue, behaviour at high and low temperatures, the effects produced by poisons and anæsthetics, the responses are identical with those hitherto held to be characteristic of muscle and nerve and of the sensitive plants. He drew the final conclusion that the underlying phenomena of life are the same in both animals and plants, and that the electrical responses which he had demonstrated are but the common physiological expression of these.—Dr. O. Stapf read a paper on the fruit of *Melocanna bambusoides*, Trin., an endospermless viviparous genus of Gramineæ. Fruits of this very singular grass collected last year were forwarded through Mr. Wild, Conservator of Forests, Bengal. They are of the shape and size of small apples or inverted pears, usually terminating with a short or long beak, the longest measuring as much as 5 inches in length. They consist of a hard, thick, fleshy pericarp, which contains a great deal of starch stored in a parenchymatic tissue, of a testa developed as nutrient layer and present in the mature fruit in an "obliterated" condition, and an embryo possessing an enormous ellipsoid scutellum which fills up the large central cavity of the pericarp, or is partly empty. The epidermis of the scutellum is developed as haustorial epithelium of the kind characteristic of grass-seeds, so far as it is in contact with the pericarp or, rather, the nutrient layer. It is traversed by numerous vascular strands which start from a plate of tangled strands in the axis of the embryo, and send out innumerable branchlets near the surface of the scutellum. The fundamental tissue in which the strands are embedded is delicately walled parenchyma, full of starch. There is no endosperm. Germination starts while the fruits are still on the tree, and the young shoots may attain a length of as much as 6 inches, whilst a bundle of roots is formed simultaneously. During germination, the scutellum acts on the pericarp as it acts in typical grasses on the endosperm, depleting not only the store of starch and other nutrient matter deposited in the cells of the parenchyma, but finally inducing also the partial solution of the cell-walls. This structure of the fruit of Melocanna is almost unique in grasses, and was not known before. It is probably repeated, although with some modifications, in the genera Melocalamus and Ochlandra, which the author intends to make the subject of another paper.—Messrs. A. O. Walker and Andrew Scott read a paper on Crustacea Malacostraca from the island of Abd-el-Kuri, in the Red Sea, collected by Messrs. H. O. Forbes and W. Ogilvie Grant during their expedition to Socotra in 1899. The specimens described were picked out of the residue from a collection of Algæ procured in April of that year, in rock pools

and tidal inlets on the above-named island. Of 13 species thus obtained, seven were described as new to science and three were regarded as belonging probably to new genera. One of these genera (Kuria), it appeared, could not be referred to any of the recognised families of Amphipoda.

Zoological Society, March 18.—Dr W. T. Blanford, F.R.S., vice-president, in the chair.—Dr. H. Gadow, F.R.S., read a paper on the evolution of horns and antlers. He stated that three main types could be distinguished in the evolution of the ornamental weapons on the heads of ruminants, and that all these types were referable to an ancient condition in which the beginning weapon, be it one of offence or defence, appeared as a mere exostosis with a thickened skin-pad. This stage resembled that of Dinoceras of the Eocene. Secondly, there was found exostosis of the frontal bone producing a pedicle, surmounted by a cartilaginous mass of apical growth, which by subsequent basal ossification became an antler. Skin originally unaltered and hairy; this, and the chondrostoma or cartilaginous later osseous growth, was shed periodically and constituted the cervine type. A side issue of type ii. was that of pro-giraffe-like animals. Cartilaginous growth preponderant, with multiple and broadened bases. Ossification delayed, but still proceeding from the base, *e.g.* the Samotherium of the topmost Miocene. A further development of this type (ii. *a*) was shown by the giraffe, in which the outgrowth proliferated freely and now formed free growths, ossifying independently, of the cranial bones, but ultimately fusing with them. Type iii. was a continuation of the main line from ii., represented by the prong-buck; predominant epidermal growth produced a horn-shoe, which was periodically shed, but had abolished the shedding of the bony core which represented the antler. Type iv., the highest stage, was represented by the hollow-horned ruminants, in which the horn-shoe was now a permanent feature; but it was important to note that these animals still shed the first, or earliest, generation of the horny sheath. Horns and antlers were developed alike with a cartilaginous matrix, with subsequent ossification. These four types were an illustration of onward phyletic evolution, and these stages were still faithfully repeated in the development of the recent species; this was a clear instance where ontogeny was a shortened recapitulation of phylogeny.—Mr. R. Trimen, F.R.S., communicated a paper by Lieut.-Colonel J. M. Fawcett, entitled "Notes on the Transformations of some South-African Lepidoptera." This memoir was in continuation of one by the same author, already published in the Society's *Transactions*. It illustrated the earlier stages of thirty-two species, of which six belonged to the Rhopalocera and twenty-six to the Heterocera.—Mr. R. I. Pocock gave an account of a new stridulating organ discovered in the scorpions belonging to the African genus Parabuthus. This organ consisted of a granular sharpened or finely ridged area upon the dorsal side of the seventh abdominal somite and of the first and second segments of the tail. The sound was produced by scraping the point of the sting over these granular areas.—A communication from Dr. R. Broom, on the organ of Jacobson in the elephant-shrew, was read, in which the author showed that the organ of Jacobson, which in Erinaceus was of the Eutherian type, was in Macroscelides marsupial in all its details, and was most nearly comparable to that of Perameles. Pointing out that in the allied genera Petrodromus and Rhynchocyon marsupial characters had been discovered by Parker in the skull, the author concluded that Macroscelides was "a very near relation of the marsupials, and had probably little affinity with the more typical insectivores." Dr. Broom noted that Macroscelides had a discoidal deciduous placenta, and that its young were born in a well-developed condition.—A communication from Mr. Frederick Chapman contained an annotated list of the collections of Foraminifera and Ostracoda made by Dr. C. W. Andrews on Cocos Keeling Atoll in 1898.—Mr. G. A. Boulenger, F.R.S., described three new species of fishes from the French Congo under the names *Allabenchelys longicauda* (gen. et sp. nov.), *Labeo lukulae* (sp. nov.) and *Chilochromis duponti* (gen. et sp. nov.).

Entomological Society, March 19.—Dr. F. Du Cane Godman, F.R.S., vice-president, in the chair.—Mr. W. J. Kaye exhibited a number of insects from British Guiana, many of them taken by himself, illustrative of Müllerian mimicry. Dr. DuCane Godman remarked that in these regions many different forms of the same butterfly would often occur within a radius of fifty miles, showing a wide range of variation.—Prof. E. B. Poulton, F.R.S., exhibited cocoons of *Malacosoma neustria* collected by Mr. Hamm in 1900, spun upon black-currant and apple-trees in his garden at Oxford. All of them had been attacked by birds through the leaf, this being the thinnest part of the cocoon, and the pupa thus more easily abstracted. With regard to the resting habit of *Hybernia leucophearia*, he said that Mr. Hamm had observed that this moth usually rested in a horizontal position. Dr. Longstaffe said that all the specimens he had observed on green stems affected a similar position, and that he had only found one on a birch-tree. Mr. M. Jacoby said that he never found the species on oak at all, but on palings, also in the same position, which facts Prof. Poulton said tended to show that the protective instinct of the species was retained in such localities.—Mr. G. T. Porritt exhibited two bred black *Larentia multistrigaria* from Huddersfield, and said that the dark form was rapidly increasing in Yorkshire. Of those already emerged and reared from the same brood, three were normal and two dark.—Dr. Frederick A. Dixey read a paper, illustrated by lantern slides, entitled, "Notes on some cases of Seasonal Dimorphism in Butterflies, with an account of Experiments made by Mr. Guy A. K. Marshall." He said that he had long since formed the opinion that *Catopsilia crocale*, Cram., was specifically identical with *C. pomona*, Fabr., and had suspected that the differences between them might prove to be seasonal in character. The belief in their specific identity was held by Piepers and by de Nicéville, neither of whom, however, thought that the dimorphism thus shown had any relation to the seasons. Colonel Yerbury said that a temporary rainfall in a dry season in dry places had a marvellous effect in producing intermediate and wet-season forms. Mr. F. Merrifield pointed out the difference between experiments upon tropical and European species. In the tropics there are not any very great distinctions of seasons and temperature, whereas in temperate climates the seasons are clearly marked off from one another. Prof. E. B. Poulton expressed his opinion that by breeding species through, Mr. Marshall had proved that one form gives rise directly to the other, the pairing of the two forms being a biological test of very considerable value. Colonel Swinhoe, Dr. Jordan and Dr. F. DuCane Godman also joined in the discussion.—Prof. Poulton, F.R.S., read a paper on mimicry illustrated by the Sanger-Shepherd three-colour process, supplementary to his paper read at the meeting of the Society on March 5.

Mineralogical Society, March 25.—Dr. Hugo Müller, F.R.S., president, in the chair.—Mr. G. T. Prior contributed a paper on the petrology of British East Africa, the result of examinations of the collection of rock specimens made by Prof. J. W. Gregory during his expedition to Mt. Kenya and Lake Baring in 1892–3, and of collections from the Uganda Protectorate made recently by Sir Harry Johnston. Descriptions were given of the three main groups of rocks, viz., the basement Archœan gneisses and schists, the Palæozoic shales and sandstones and the Tertiary volcanic rocks. The gneisses and schists are associated with dykes both of acid pegmatites and of basic diabasis and epidiorites, and also with granulitic rocks analogous to the Charnockite series of India and Ceylon. Of the Palæozoic Karagwe series a collection of ferruginous shales and siliceous schists from Unyoro was described. These rocks present striking similarities with those of Hatch's Hospital Hill series of the Transvaal and with rocks from the Ingwenyaberg, Swaziland, and a correlation between the Karagwe series and the Cape System of the Transvaal was suggested. The volcanic rocks consist mainly of soda-rich phonolitic rocks which have resulted doubtless from a nepheline-syenite magma. The lavas from the volcanoes of the Great Rift Valley and of Mt. Kenya and the region between are characterised, like those of the Canary Islands and the Azores, by the prevalence of anorthoclase, by the large amount of soda-amphiboles (cossyrite, catophorite, arfvedsonite) as well as of soda-pyroxenes and by the absence of sphene and noseau. They form a remarkable example of a rock-series showing a gradation in composition from basic phonolites, containing nepheline both in large phenocrysts and in the groundmass, through phonolitic trachytes containing no recognisable nepheline, to phonolitic quartz trachytes, and finally to acid riebeckite-rhyolites containing much quartz. The later eruptive rocks from Mt. Elgon and the western side of the Great Rift Valley present some points of distinction with the earlier erupted rocks. They are generally of a more basic character like those of Kilimanjaro as compared with those of Mt. Kenya. Another point of distinction is the presence in them of titanic acid in large amount, in the form of

perofskite in the more basic nephelinites, and as sphene in the phonolites which are of the more ordinary type without soda-amphiboles. Most of the specimens from Mt. Elgon and the neighbourhood consist of nephelinites, but in some of them the nepheline, both as phenocrysts and in the groundmass, is partially or wholly replaced by melilite. Examples of melanite-nepheline rocks allied to borolanite, and of monchiquite dyke-rocks from Mt. Elgon, were also described. A specimen of nephelinite from the neighbourhood of Ruwenzori containing much perofskite suggested the contemporaneity of the eruptive rocks of Mt. Elgon and of the volcanic region at the foot of Mt. Ruwenzori.

Royal Meteorological Society, March 19.—Mr. W. H. Dines, president, in the chair.—Mr. W. N. Shaw, F.R.S., read a paper on la lune mange les nuages, which was really a note on the thermal relations of floating clouds. He also exhibited an arrangement of apparatus whereby the conditions applicable in the case of a floating cloud can be experimentally realised.—Mr. F. J. Brodie read a paper on the prevalence of gales on the coasts of the British Islands during the thirty years 1871–1900. The total number of gales of all kinds dealt with during this period was 1455, the yearly average being 48·5, of which 10·6 were severe. The worst year was 1883, while the quietest was 1889. The stormiest month was January, 1890. At all seasons of the year excepting the summer, the prevalence of gales from south-west is greater than from any other quarter. The minimum of such gales is reached in the spring, when rather less than 20 per cent. are from south-west, more than half the storms being, however, from points between south-west and north-west. The prevalence of gales from polar directions is then at its maximum, more than 21 per cent. blowing from points between north and east. In the spring of 1883, out of a total of eleven gales no fewer than seven were from these quarters, the proportion being about three times the average. The highest velocities recorded were those at Fleetwood during the westerly gales on December 22, 1894, and on January 12, 1899. On the former occasion, for nine hours, from 7 a.m. to 3 p.m., the mean velocity was sixty-four miles per hour, and at 9 a.m. it reached a maximum of seventy-eight miles. It appears that on the average 43 per cent. of the storm systems which visit our coasts advance from some point of the compass lying between south and south-west, and travel towards some point lying between north and north-east. 39 per cent. have an easterly motion, while less than 1 per cent. move westwards. A mean of 264 cases shows that the deep cyclonic systems which visit our islands travel on an average at the rate of 24·1 miles per hour; in some cases, however, the rate was not more than eight or ten miles, while in others it amounted to forty, fifty and even sixty miles per hour. The author concluded his paper by exhibiting a series of weather maps showing the progress of some of the most notable gales during the period covered by the discussion.

CAMBRIDGE.

Philosophical Society, March 3.—Prof. Macalister, president, in the chair.—On a method of increasing the sensitiveness of Michelson's interferometer, by Mr. H. C. Pocklington. It is shown that the sensitiveness of Michelson's interferometer can be greatly increased if we can cause the interfering beams to be circularly polarised in opposite senses. This can be done approximately in the ordinary form of the instrument (with, however, an unsilvered inclined mirror) by placing an eighth-wave plate of mica in front of each of the perpendicular mirrors so that a principal axis of each plate is parallel to the line of intersection of the mirrors, and suitably choosing the plane of polarisation of the incident light. A theoretically better method, in which the inclined mirror and the compensating plate are placed rather less than a quarter-wave apart, is discussed, but it is concluded that only experiment can decide which will be the better method in practice.—The influence of currents in metals on reflected and transmitted light, by Mr. P. V. Bevan.—(*a*) On the conductivity of the vapours of the alkali metals; (*b*) on induced radio-activity, by Prof. J. J. Thomson. The investigation was undertaken with the intention of seeing whether the "induced radio-activity" shown by a metal rod after long-continued negative electrification in the open air would occur if the rod were placed in a closed vessel instead of outside in the open air. The closed vessel was a zinc gasometer 102 cm. high and 75 cm. in diameter; the vessel was insulated and used as one of the electrodes, the other electrode was a metal tube placed at the axis of the cylindrical gasometer. A potential difference of 800 volts between the cylinder and this rod was produced and the current between these electrodes was measured. This current was "saturated" and was therefore a measure of the total ionisation in the gas in the vessel; if the rod became radio-active, the ionisation and therefore the current would increase. The current was measured in the morning, and the rod in the vessel kept connected with the negative terminal of a Wimshurst machine for six or seven hours, when it was disconnected from the machine and the current again measured; if the gas in the vessel were not exposed to Röntgen rays whilst the rod was negatively electrified, the author was not able to detect any increase in the current through the gas as the result of the long negative electrification: if, however, the gas were exposed to Röntgen rays during the negative electrification of the rod, then a well-marked increase in the current took place—the increase being some 16 or 17 per cent.; this increase was due to some alteration in the rod and not to a change in the gas in the vessel, for if a rod similar to the one which had been electrified, but which had not itself been electrified, were substituted, the current sank to its former value. No increase took place in the current if the rod were positively electrified. A number of experiments were made on the currents through the vessel when the vessel was not exposed to rays and when the rod was not electrified. Rods of different sizes and different metals were tried—these all gave approximately the same current; if the rod were carefully wrapped round with dry filter paper, the current showed a decided increase, while if the filter paper were damp, the current was many times its value for the bare rod; the current in this case is greatest when the negative ions move up to the paper-covered rod—a large effect is also produced when the paper is wetted with brine or alcohol, but a solution of H_2O_2 produces by far the largest effect yet found.—On the Hall effect in gases at low pressures (second paper), by Mr. H. A. Wilson. The experiments described in this paper are a continuation of those described in the paper entitled "On the Hall Effect in Gases at Low Pressures" (*Proc.* Camb. Phil. Soc., vol. xi. pt. iv.), read to this Society last October. Measurements have been made of the Hall effect and electric intensity in the uniform positive columns in oxygen and hydrogen, and also of the variation of the Hall effect along the discharge in air at various pressures. The Hall effect in hydrogen is found to be capable of being represented by the equation

$$z = 2{\cdot}65 \times 10^{-2}\frac{H}{p},$$

where z is the transverse electric intensity or Hall effect, H the magnetic field and p the pressure in millimetres of mercury. The corresponding equation for oxygen is found to be

$$z = 3{\cdot}8 \times 10^{-3}\frac{H}{p}.$$

The electric intensities in hydrogen and oxygen are found to be given by the equations

$$X = 28\sqrt{p}$$

and $$X = 26{\cdot}9\sqrt{p} \text{ respectively.}$$

The results on the variation of the Hall effect along the discharge are shown by curves which resemble the curves showing the variation of the electric intensity along the discharge. The paper concludes with some theoretical discussion of the results.—On the extraction of the gases from one cubic centimetre of blood, by Mr. J. Barcroft.—On the coefficient of mutual induction between a circle and a circuit with two parallel sides of infinite length, by Mr. G. F. C. Searle.—Notes on Semper's larva, by Mr. K. Ramunni Menon.

EDINBURGH.

Royal Society, February 17.—Prof. Geikie in the chair.—Major W. B. Bannerman, superintendent of the Plague Research Laboratory, Parel, India, gave an account of the work carried on in the laboratory of which Mr. Haffkine is director in chief. A staff of fifty-three, of whom five are European, now occupies a huge building which has been in succession a Roman Catholic seminary, a Governor's residence, and a plague hospital. A detailed account was given of the preparation of Haffkine's prophylactic, which the Indian Government had adopted as a vaccine for the plague. Some interesting statistics were given showing that under precisely similar con-

ditions persons who had been inoculated were distinctly less liable to attack than those who had not been inoculated, that of the inoculated patients who were attacked by the plague a much smaller percentage of cases proved fatal, that the prophylactic was not harmful during the incubation stage of the disease, and that protection began to be effective twenty-four hours after injection, but was not complete until the tenth day. Profs. Fraser, Greenfield and Hunter Stewart took part in the after discussion, Prof. Fraser commenting especially on the fact that the vaccine, valuable though it had been proved to be, had not been shown to be able by itself to control a real epidemic of plague. He believed that more effective control would result from the policy of isolating patients and of enforcing better sanitation. Moreover, Haffkine's vaccine always produced a reaction which, he could not help thinking, might actually convert a case which would otherwise have terminated in recovery into a case which terminated in death. In reply Major Bannerman said he would never decry sanitary measures, but it was at present impossible to get the natives of India to appreciate the blessings of sanitation and the necessity of ventilation. The Government should be induced to introduce the teaching of hygiene into the schools, and it was an extraordinary fact that there was not a medical representative on the Viceroy's Council.—Dr. Hugh Marshall communicated a paper by Mr. J. K. H. Inglis and himself on the action of silver salts on solution of ammonium persulphate. The paper gave the results of measurements of the reaction velocity and of the influence exerted by other salts present in the solution. From these it would appear that the first part of the reaction, giving rise to the formation of peroxide of silver or similar compound, is much slower than the second part, which results in the formation of nitric acid.

March 3.—Sir William Turner in the chair.—Dr. Masterman read a paper on the early development of *Cribrella oculata*, Forbes, of which the leading points may be thus summarised. The segmentation is very variable, but always culminates in a solid morula, which is converted into a blastula by a remarkable process termed multiple egression. A normal gastrula is then produced and the blastopore closes. A process of cell-prolification then causes the formation of mesenchyme and hypenchyme (the latter filling the archenteron). In the bilateral larva the anterior cœlom gives rise to the pre-oral cœlom and to paired lateral cœloms as well as a small central cœlom; the posterior cœlom gives rise to left and right halves which fuse later. The left lateral cœlom becomes the hydrocœle; the right lateral the epigastric cœlom; the central cœlom forms the pericardium or dorsal sac; and the posterior cœlom forms the hypogastric cœlom. The transition from bilateral to radial stages throws light upon the peculiar torsion found in asterids and upon the homology of the mesoderm in echinoderms. A close comparison was drawn between the Cribella larva and Balanoglossus.—Messrs. A. E. Shipley and Edwin Wilson, in a paper on a possible stridulating organ in the mosquito, drew attention to a curious apparatus at the base of the wings of *Anopheles maculipennis*, an apparatus which had escaped the notice of both the systematist and morphologist. The structure is very complex, but consists essentially of a slightly movable bar provided with a series of well-marked teeth which in certain circumstances rasp across a series of ridges. It seems probable that as the wings are raised and depressed the movement of these two surfaces over one another may account for some of the characteristic buzzing of the mosquito.—Dr. Noel Paton gave an account of some observations on the amount of dissolved oxygen in water required by young Salmonidæ.—A paper was also read by Dr. James Scott on the influence of subcutaneous injections of large quantities of dextrose on the metabolism in the dog. It was found that dextrose injected in amounts varying from 5 to 7 grms. per kilo. was as far as possible acted upon by the general tissues of the body and not dealt with by the liver or at once secreted by the kidneys, and the result was a marked increase in proteid metabolism.

DUBLIN.

Royal Dublin Society, March 19.—Prof. Grenville A. J. Cole in the chair.—On the progressive dynamo-metamorphism of a porphyritic andesite from co. Wicklow, by Henry J. Seymour. The author described the gradual alteration of a coarsely porphyritic andesite into a finely banded crystalline schist, as the result of earth movements connected with the intrusion of the Leinster granite. The light-coloured bands in the schist consisted of the very much elongated felspar phenocrysts, which are drawn out partly by granulation and partly by recrystallisation into flat lenticles seven or eight times the length of the original crystal from which they were derived. The dark bands are composed of the altered matrix containing abundant secondary biotite.—Prof. E. J. McWeeney, on a method of air-examination by bacteriological procedure. The problem to be solved was whether the air on a certain part of the premises of a Dublin manufacturer was liable to contamination by micro-organisms carried by air currents from a refuse-heap on the premises of a neighbour, the intervening distance being 800 feet. The method consisted in liberating on the refuse-heap a readily recognisable form of micro-organism that does not normally occur in Dublin air, and exposing large Petri dishes (diameter 20 cm.) at various heights at the place where contamination was suspected. The organism used was one that formed red pigment, and was intermediate in character between *B. prodigiosus* and *B. Riliensis*. A thick suspension of this in normal saline was thrown into the air at the refuse-heap by means of a spray apparatus, at the rate of a litre per hour. This was kept up for three hours on a day when the wind was blowing in the required direction. Meanwhile six culture dishes were exposed in the perpendicular position, and at heights varying from about 12 to 60 feet above the ground. Afterwards they were closed and the colonies allowed to develop. On four of the six plates red colonies appeared, viz. on those exposed at the heights of 30, 40, 50 and 60 feet, and subculture showed the organisms composing them to be identical with those that had been sprayed. The success of the experiment was rendered the more remarkable by the fact that rain was falling in torrents throughout the three hours' exposure. The author proposed to develop the method and apply it to other problems of the like kind.

PARIS.

Academy of Sciences, April 1.—M. Bouquet de la Grye in the chair.—The new organisation of the study of astronomy and the physics of the globe at the National Observatory of Athens; the presentation of the third volume of the *Annales* of this establishment, by M. Lœwy. The first branch of work developed by M. Eginitis was that of meteorology; at the present time there is one station of the first order at Athens and twenty-one stations of the second order in various parts of Greece. At the same time a systematic study of the geodynamical phenomena of Greece was organised, a network of 550 stations uniformly distributed throughout the whole country dealing with seismic phenomena. The observations from these stations up to the present time have been analysed by M. Eginitis, the results being of great scientific interest. It is clearly shown that there is no connection between the 567 seismic disturbances noted in Greece during the year 1899 and the positions of the moon. Owing to the unavoidable delay in fitting up the astronomical instruments, this branch of work is not so well developed as the others, but aided by the fine climate, valuable observations on meteoric showers have already been recorded.—On the action of human serum on the Trypanosome of the Nagana (*Tr. Brucei*), by M. A. Laveran. It would be supposed that the injection of the serum of an animal naturally immune, such as man, from the attack of the tsetse fly would be without effect in the treatment of animals suffering from the effects of the bites; contrary to expectation, however, human serum has proved to be active. Infected rats and mice, injected with human serum, lost the characteristic organism in from twenty-four to thirty-six hours after the injection. On account of the close analogy between the monkey and man, it appeared to be of interest to compare the action of serum from man and the monkey; the latter serum was found to be quite inactive. The effect of human serum as a preventive against the disease was next tried, but the immunity produced was feeble.—On surfaces of constant negative curvature, by M. Erik Holmgren.—On the heat of solidification of solid ammonia, by MM. de Forcrand and Massol.—A self-recording atmospheric electroscope, by M. G. Le Cadet. An image of the aluminium leaves of the electroscope was projected through a very fine slit on to a revolving sensitised plate. The chief difficulty was due to the extreme fineness of the leaves, this being got over by tilting the box of the electroscope with respect to the optic axis of the apparatus.—On the band spectra

of nitrogen, by M. H. Deslandres. Four distinct groups, characterised by their limits of vibration frequency, have been made out in the spectrum of nitrogen. Cuthbertson has recently shown that the forty bands of the first group can be arranged in thirteen series. Some further regularities in these series are discussed in the present paper.—The cause of the annual period of the aurora borealis, by M. Charles Nordmann. It is known that in mean latitudes the frequency of the aurora possesses a double annual periodicity such that the maxima are at the equinoxes and the minima at the solstices. The author deduces a theoretical explanation of this, which is independent of all hypotheses as to the nature or production of the aurora —On the composition of the lodes of Kersanton, by M. Ch. Barrois. The veins of Kersanton are distinguished from ordinary veins by their composite structure; they have been slowly consolidated under the influence of pneumatolithic phenomena for a very long time. The facts observed are in accord with the theory of M. Michel Levy.—An examination of the meteoric iron of Guatemala, by M. Stanislas Meunier. Analysis showed that the Guatemala iron belongs to the Schwetzite type and is similar to the masses of Descubridora (Mexico, 1780), Werchne-Udinsk (Siberia, 1854) and Schwetz (Prussia, 1857).—The best methods of realising stereoscopic radioscopy, by M. Th. Guilloz.

DIARY OF SOCIETIES.

THURSDAY, APRIL 10.

MATHEMATICAL SOCIETY, at 5.30.—A Note on Divergent Series: Dr. Hobson, F.R.S.—Stress and Strain in Two-dimensional Elastic Systems: Prof. Love, F.R.S.

INSTITUTION OF ELECTRICAL ENGINEERS, at 8.—Problems of Electric Railways: J. Swinburne and W. R. Cooper.

ROYAL INSTITUTION, at 3.—The Oxygen Group of Elements: Prof. Dewar, F.R.S.

FRIDAY, APRIL 11.

PHYSICAL SOCIETY, at 5.—An Apparatus or Vapour-pressure Measurements: Mr. Grant.—(1) The use of Cathode Rays for Alternating-Current Measurements; (2) An Experiment on the Current Growth in an Inductive Circuit: Mr. Morris.—An Electric Heater: Dr. R. A. Lehfeldt.—Note on the Compound Pendulum: S A. F. White.

ROYAL ASTRONOMICAL SOCIETY, at 5.—(1) Cape Double Star Results, 1901: (2) Notes on Nebulæ: Royal Observatory, Cape of Good Hope.—Explanation of Use of Tables of $\frac{1}{2}(\theta + \cos\theta)$: W. S Aldis.—On Stationary Meteor Radiants; Third Paper: H H. Turner.—Results of Double Star Measures at Windsor, New South Wales, in 1901: J. Tebbutt.—Saturn seen through the Cassini Division: C. T. Whitmell.—On the Probable Motion of some of the Small Stars in the Dumb-bell Nebula: E. E. Barnard.—On the Supposed Variability of κ Persei and 36 Persei and a Comparison of the Photographic and Visual Magnitudes of those Stars: W. H. Robinson.—*Probable paper:* On the Relative Number of Star Images photographed in Different Parts of the Plate, and on the Performance of Various Object-Glasses in this respect: H. H. Turner.

MALACOLOGICAL SOCIETY, at 8.

ROYAL INSTITUTION, at 9.—Problems of the Atmosphere: Prof. Dewar, F.R.S.

MONDAY, APRIL 14.

SOCIETY OF ARTS, at 8.—Glass for Optical Instruments: Dr. R. T. Glazebrook, F.R.S.

ROYAL GEOGRAPHICAL SOCIETY, at 8.30.—A Journey from Omdurman to Mombasa *viâ* Lake Rudolf: Major H. H. Austin, C.M.G.

TUESDAY, APRIL 15.

ZOOLOGICAL SOCIETY, at 8.30.—Contributions to the Osteology of Birds; Part V. Falconiformes: W. P. Pycraft.—On the Windpipe and the Heart of the Condor: F E. Beddard, F.R.S.—Field-notes upon some of the larger Mammals of Patagonia: Hesketh Pritchard.

ROYAL INSTITUTION, at 3.—Recent Methods and Results in Biological Inquiry: Dr. Allan Macfadyen.

INSTITUTION OF CIVIL ENGINEERS, at 8.—*Discussion:* The Greenwich Footway-Tunnel: W. C. Copperthwaite.—Subaqueous Tunnelling through the Thames Gravel, Baker Street and Waterloo Railway: A. H. Haigh.—*Paper to be read:* On Locomotive Fire-box Stays: F. W. Webb.

ROYAL STATISTICAL SOCIETY, at 5.—Factory Legislation considered with reference to the Wages, &c, of the Operatives protected thereby: Geo. H. Wood.

WEDNESDAY, APRIL 16.

SOCIETY OF ARTS, at 8.—Photography as applied to Architectural Measurement and Surveying: J. Bridges Lee.

GEOLOGICAL SOCIETY, at 8 (1) The Carlisle Earthquakes of July 9 and 11, 1901; (2) The Inverness Earthquake of September 18, 1901, and its Accessory Shocks: Dr. Charles Davison.—The Wood's Point Dyke, Victoria (Australia): F. P. Mennell.

ROYAL MICROSCOPICAL SOCIETY, at 7.30.—Exhibition of Pond Life.

ENTOMOLOGICAL SOCIETY, at 8.—On the Economic Importance of the Parasites of Coccidæ: Alice L. Embleton.—Eastern and Australian Geometridæ in the British Museum Collection: Colonel Charles Swinhoe.

ROYAL METEOROLOGICAL SOCIETY, at 7.30.—Clouds: Capt. D. Wilson-Barker.

THURSDAY, APRIL 17.

ROYAL INSTITUTION, at 3.—The Oxygen Group of Elements: Prof. Dewar, F.R.S.

SOCIETY OF ARTS, at 4.30.—Recent Developments in Punjab Irrigation: Sidney Preston.

LINNEAN SOCIETY, at 8.—The Anatomy of Todea with Notes on the Affinity and Geological History of the Osmundaceæ: A. C. Seward, F.R.S., and Miss Sybil O. Ford.—On the New Zealand Phyllobranchiate Crustacea, Macrura: G. M. Thomson.

CHEMICAL SOCIETY, at 8.—Oxonium Salts of Fluoram and its Derivatives: J. T. Hewitt and J. H. Tervet—The Influence of certain Acidic Oxides on the Specific Rotations of Lactic Acid and Potassium Lactate: G. G. Henderson and D. Prentice.—(1) The Amounts of Nitrogen as Ammonia and as Nitric Acid, and Chlorine in the Rain-water collected at Rothamsted; (2) The Amounts of Nitrogen as Nitrates and Chlorine in the Drainage through uncropped and unmanured land: N. H. J. Miller.

FRIDAY, APRIL 18.

ROYAL INSTITUTION, at 9.—The Autocar: Sir J. H. A. Macdonald.

EPIDEMIOLOGICAL SOCIETY, at 8.30.

INSTITUTION OF CIVIL ENGINEERS, at 8.—The Erewash Valley Widening and Toton Sidings: H. C. M. Austen.

INSTITUTION OF MECHANICAL ENGINEERS, at 8.—The Standardization of Pipe Flanges and Flange Fittings: R. E. Atkinson.

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THURSDAY, APRIL 17, 1902.

THE EVOLUTION OF MARRIAGE.

The Mystic Rose: a Study of Primitive Marriage. By Ernest Crawley, M.A. Pp. xviii + 492. (London: Macmillan and Co., Ltd., 1902.) Price 12s. net.

THE interest of the scientific problems concerning the origin and development of the marriage relation is perennial. A large part of that interest, though by no means all of it, is derived from the complexity of the factors, the obscurity enshrouding the prehistoric development of the race, and the consequent difficulties attending all investigations into primitive culture. It is forty years since Bachofen published his work on "Das Mutterrecht," to which may fitly be applied that much-abused epithet "epoch-making," for it initiated all really scientific inquiry into the subject. Since then anthropologists, one after another, have incessantly attempted to complete, to correct or to controvert the bold Swiss jurist's conclusions. Mr. Crawley is the latest in the field. He comes well-equipped for his task. He brings psychology to the aid of anthropology, and many of his psychological observations display real insight and throw an important light upon the customs described. His reading has been wide, and his illustrations are generally well chosen. But he rests too often upon second-hand authorities like Ploss and Featherman when the original sources are not difficult to reach, overlooking the possibility that the context of passages used by such compilers may seriously modify their summaries.

Mr. Crawley's theory of marriage is founded upon the universal institution (if it be right to call it an institution) of taboo. He holds that man was probably not always gregarious. At all events, "in early society he had none of the solidarity of clan, tribe, or kin, which is often attributed to him." He was strongly individualistic. As an individual he felt both attraction and repulsion for society. He longed for union with others, and yet he feared their influences. This conflict of emotions gave birth to the complicated system of taboo. It was naturally strongest in the mysterious allurements and repulsions of sex. Next to the craving for food, sexual desire is the most powerful of human appetites. The difference of sex, entailing a difference of physical function, of physical and moral aptitudes and of occupations, inevitably divided man from woman. It produced a sense of strangeness, which behoved caution. That very strangeness, and the consequent shyness, intensified the attraction. All the strength of taboo was therefore concentrated upon sexual relations. From their early days children of different sexes were more or less separated. At puberty (a time of special danger) that separation was emphasised by ceremonies, explained by instruction, and rendered perpetual by the vocations of the two sexes. But separation is impossible. The sexes instinctively seek one another. The puberty-ceremonies, therefore, are a preparation for new and closer relations. Very often they amount to preliminary marriage-rites, espousing the one sex to the other in the abstract, and preparing it for the concrete individual union to be consummated in due time. They do not, however, remove the dangers "responsible for the taboo between the sexes and the various sexual properties of which the contagion is feared." It is the function of the marriage-ceremonies proper "to neutralise these dangers and to make the union safe, prosperous and happy," and, moreover, to bind the contracting parties "so as to prevent, if possible, later repudiation." The object "is not, and never was, to join together the man or the woman, as the case may be, with 'the life, or blood, or flesh of the *tribe*.' There is no trace of this sentimental socialism in primitive society, though there are facts which look like it, no more than there is or ever was a community of wives; marriage is between individuals and is an individualistic act. The mere existence of the egoistic impulse, not to be casually identified with jealousy, is enough to discredit the suggestion; and the tendency of society from primitive animalism upwards has been from individualism to socialism. It is a perversion of history and of psychology as well, to make man more communistic the more primitive he is."

From this sketch of the argument it will be seen that the author arrives at the main conclusions of Dr. Westermarck in his "History of Human Marriage," but by a different route. The wide, if not universal, prevalence of a complicated system of taboo among savages is explained by a primitive individualism. This primitive individualism, if it existed in the full force ascribed to it by Mr. Crawley, must, however, have resulted from the solitary habits of our primitive human and pre-human ancestors. But were their habits solitary? No attempt is made by Mr. Crawley to prove this. Dr. Westermarck certainly attempted it, but his evidence is meagre, vague, often contradicted by his own witnesses, and generally unsatisfactory. The most it could be held to show was that certain outcast races like the Veddahs live ordinarily in pairs or very small communities; while other low races disperse, when food is scarce, into small separate hordes or families to search for sustenance, coming together again at other times. Seeing that mankind, wherever they have been found in a savage state, are, with such exceptions as these, found gregarious, a heavy onus of proof surely lies on those who either assert or assume the race to have been originally solitary. The fear of all contact, to which Mr. Crawley reduces, as its lowest term, the influence of taboo, must have arisen from normal absence of contact, and especially of contact with the opposite sex. But this even Dr. Westermarck's evidence does not prove. Had it been the case, mankind would have speedily perished in the struggle for existence, or been confined, like the higher apes, to limited districts and small numbers. Space to discuss the matter here is wanting. It must suffice to say that the evidence seems to me to point to the development of mankind from a gregarious ape or ape-like being, and that all theories based on a contrary assumption at present lack support.

Among such theories is that of a primitive monogamy. The opposite theory—that of a primitive promiscuity—does not imply perpetual, unbounded, meretricious change of partners. There is some reason to think that mankind, like other mammals, had once a definite breeding-season. If so, the conduct of other mammals subject to "rut" may lead us to suspect that constancy on the part of women at such times was hardly more pronounced

than on the part of men. Nor would such inconstancy be sufficient to produce a pathological condition unfavourable to reproduction, as urged by Maine and Westermarck. As humanity advanced, the organisation of society would compel limitations of licence, which would not necessarily take everywhere the same form. They might very well result in such practices as those of the South Australian tribes (which, despite Mr. Crawley's pleading, bear marks of a transitional character), of many Bantu tribes, of the Eskimo, and of the Seri, perhaps the lowest of all extant peoples. It may be said that this is speculation, since we have no positive proof of a breeding-season, or of the primitive habits of mankind. No doubt it is. But we have to account as best we may or practices not consonant with monogamy. And the fact remains that Mr. Crawley has omitted to study the various forms of the marriage-relation, personal choice among savages, the rights of the husband's kin in the wife and of the wife's kin in the husband, and other subjects the due consideration of which is essential to a correct solution of the problem.

I cannot, therefore, regard "The Mystic Rose" as a complete or satisfactory account of "primitive marriage." I must not, however, be understood to think that it is anything but a valuable contribution to the discussion of the evolution of sexual relations in man. If the author's attention has been absorbed by taboo, it must be remembered that the influence of taboo is an aspect of the theme hitherto greatly neglected. His researches have, consequently, thrown unexpected light on a number of questions which arise out of the strange and what seem to us the preposterous customs of savages. Science has not yet attained the point at which it is possible to identify and unravel all the strands of the tangled web of the history of human marriage. To single out one of the strands for careful and concentrated study helps us appreciably forward. A few more such works, and we may hope to be brought within measurable distance of the goal. E. Sidney Hartland.

CLIMATOLOGICAL ATLAS OF THE RUSSIAN EMPIRE.

Atlas climatologique de l'Empire de Russie. Publié par l'Observatoire physique central Nicolas, à l'Occasion du cinquantième Anniversaire de ses Fondation, 1849–1899. (St. Petersbourg, 1900.)

THIS magnificent atlas has been prepared by Director Rykatchew and published in commemoration of the fiftieth anniversary of the foundation, by the Emperor Nicholas I. on April 1, 1849, of the Central Physical Observatory. The atlas comprises eighty-nine large meteorological maps, together with fifteen graphical tables, which give the best presentation hitherto published of the main features of the climates of the great Eurasian Empire of Russia. Previous to 1849, the meteorology of Russia was prosecuted chiefly by the establishment of first-class meteorological observatories in different parts of the empire, at which eye observations were made hourly by night and by day. It is scarcely possible to exaggerate the importance of these hourly and other results in furthering the development of the science. Indeed, it may be safely predicted that in future developments of meteorology the knowledge thus obtained of the hourly variations from year to year of pressure and temperature, the two prime elements of climate, will always hold a prominent place, more particularly in investigating the relations of meteorology to the secular solar changes.

About the same time Kupfer added considerably to the number of second-order stations, and from this combined system of observation, fuller and more satisfactory climatic data began to be available for different parts of the empire; and when isobaric charts were first published in 1868, no country in the world outrivalled Russia for the importance of the data contributed to the undertaking. Immediately thereafter a phenomenal increase of meteorological stations took place in almost all countries; and here again, with the appointment of Wild as the Director of the Meteorological Department of Russia, the empire took a first position, whether regard be had to the number and quality of the stations or to the wide extent and diversified character of the climates over which they spread.

By the beginning of 1871 this great change may be regarded as having been substantially made. It is with the observations during the thirty years from 1871 to 1900 that the "Climatological Atlas" mainly deals. Quite a large number of stations have been established since 1871, the observations from which have been incorporated and utilised in the preparation of the atlas and the accompanying text by Rykatchew and the collaborators who have written the different sections of this great work.

The atlas gives, for the months and for the year, thirteen charts for each of the departments of pressure, temperature, vapour tension and relative humidity; and similarly five charts for the seasons and the year showing the rainfall, the days of precipitation, and the cloudiness. Additional charts are added representing the annual range of the mean temperature, the absolutely highest and the absolutely lowest observed temperatures, and the absolute range of temperature for each station for the whole time under review. Here it is interesting to note that the lowest temperature anywhere observed on the globe hitherto is $-90^{\circ}\cdot0$ Fahr. at Werkojansk, at a height of 460 feet, lat. 67° 34′ N., long. 133° 51′ E., in the valley of the Yana. On the other hand, the highest temperature was $110^{\circ}\cdot8$, in the arid region of the Trans-Caucasian province. Two charts show the months of greatest and of least precipitation, two the greatest and the least number of rainy days, and two the seasons of greatest and of least cloudiness of the sky. Three charts show the opening and the closing of rivers with ice, one chart the number of days snow lies on the ground, and another the number of days of thunderstorms. Finally, five charts exhibit the paths of cyclones and the types of weather in Russia. The charts, which measure 16 to 27 inches, are printed in colours, showing at once and effectively the geographical distribution of the different elements of climate intended to be represented.

The data showing the mean results of pressure, temperature and other elements of climate, represented on the coloured charts, are given on twenty-seven graphical plates. The usual method is to publish in numerical

tables; but the method now adopted is attended with the great disadvantage of adding enormously to the labour of examining the work critically.

In 1868 the most serious desideratum in Russian meteorology was the large number of undetermined heights among the stations. But shortly thereafter Wild commenced vigorously to make good this great defect, and his successor, Rykatchew, is successfully carrying out this good work. It is much to be desired that in a few years it will be completed. The more important desiderata still outstanding are large portions of northern and south-eastern Siberia.

The new hypsometrical and meteorological data put before us in this atlas are exceedingly valuable accessions to meteorology. For while the broad features of the geographical distribution of pressure and temperature, as previously disclosed, remain substantially the same, yet the fresh data now submitted result in many cases in more accurately defined positions of the isobars, isotherms and wind direction in their occurring changes from month to month.

It is truly a genuine pleasure to the climatologist to use these rectified monthly isobars and isotherms in explanation of the monthly changes in the geographical distribution of snow and rainfall, number of days of precipitation, humidity, cloudiness and other weather phenomena in their all-important bearings on the agricultural and other economic interests of the Russian Empire. Prof. Rykatchew and his singularly able staff are to be congratulated on the successful termination of this great work.

ALEXANDER BUCHAN.

A FRENCH CRITIC OF MAXWELL.

Les Théories électriques de J. Clerk Maxwell. Étude historique et critique. Par M. P. Duhem. Pp. 228. (Paris: A. Hermann, 1902.) Price fr 8.

IN this work the earlier writings of Maxwell on electrical subjects, as well as his "Treatise on Electricity and Magnetism," are discussed. The general attitude is somewhat severe, as may be inferred from the following extract translated from the preface:—

"The different theories of the Scottish physicist are irreconcilable with the traditional theory; they are irreconcilable with each other. . . . At each instant it seems that the result even of his own reasoning and of his calculations is going to drive Maxwell to impossible and contradictory results; but . . . Maxwell makes an embarrassing term disappear, changes an inacceptable sign, transforms the meaning of a symbol; then, having passed the dangerous spot, the new electric theory, enriched by a paralogism, pursues its deductions."

Of the electrostatics in the paper "On Faraday's lines of force," which Prof. Duhem regards as the first of three different theories of statical electricity propounded by Maxwell, his concluding remark is that it is only the semblance of a theory. Maxwell states sufficiently clearly, we should have thought, that his object was not to establish any physical theory, but to point out certain analogies between lines of force and lines of flow.

Of the theory developed in the paper "On physical lines of force," Prof. Duhem writes that it does not even lead to the expression in equations of the problem of the polarisation of a given dielectric medium; this seems to be because Maxwell assumes without formal proof that the function whose spacial differential coefficients express on his theory the electromotive force is identical with the potential of the classic theory; it seems very easy to rectify the omission.

Altogether too much capital is made of Maxwell's unfortunate confusions of sign, and it seems puerile to complain of the use of the popular term "electric tension" where "electric pressure" is required by strict analogy.

Prof. Duhem's objection to Maxwell's interpretation of the various terms in the expression obtained for the magnetic force[1] appears well grounded.

In discussing the third electrostatic theory of Maxwell, as contained in the paper "On a dynamical theory of the electromagnetic field" and in the "Treatise," comments are made on the obscurity of Maxwell's idea of electric displacement and on the confusion caused in the form of the equation of continuity by thinking of a charge of electricity sometimes as a real thing and sometimes as a mere fiction representing the effect of nonuniform polarisation. All readers of Maxwell know these difficulties; most will be disposed to agree with Hertz that if we interpret the word "electricity" in a suitable way, nearly all the apparent contradictions can be made to disappear, rather than follow Prof. Duhem in his *reductio ad absurdum*.

Prof. Duhem contrasts Maxwell's theory of displacement through a dielectric considered as a continuous medium having an elastic constant different from that of pure æther with the theory which regards all the phenomena as due to action at a distance on the analogy of Poisson's theory of induced magnetism. His expression for the electrostatic energy on the latter theory contains a term which is furnished by the surface separating two different dielectrics and which corresponds to the fictitious charge of electricity due to change of polarisation on crossing that surface; consequently he infers that this theory clashes with that of Maxwell. Consideration of the work actually required to charge the conductors in such a case renders it difficult, however, to see how on either theory the expression for the total organised energy can differ from that given by Maxwell. Prof. Duhem then refers to Gouy[2] as having shown that the classic doctrine completely explains the actions observed between conductors and dielectrics by Pellat,[3] among others, and concludes that such actions could not be deduced from Maxwell's theory. In the absence of precise numerical calculation and comparison with experimental results, this inference appears somewhat rash, even if the premisses were correct. Gouy, however, in the paper referred to does not consider the case of two different dielectrics at all. Pellat, moreover, considers the results of his experiments to be in perfect accordance with Maxwell's theory; he points out, however, that as his calculations of the effective forces on the surfaces of conductors and dielectrics are deduced from the variation of the electrostatic energy, his experimental results, as well as those of Quincke, may be explained without accepting Maxwell's

1 "Scientific Papers," vol. i. p. 463.
2 *Journal de Physique*, 3e série, t. v. p. 154, 1896.
3 *Annales de Chimie et de Physique*, 7e série, t. v. 1895.

theory and thus do not serve to establish it. (The simplicity and directness of Pellat's theoretical investigation seem noteworthy when compared with the discussions of Gouy and of Larmor;[1] in each of the latter some of the apparent forces have to be explained away, and they appear to contradict each other. It may be that in such discussions too much importance is at present assigned to Maxwell's stress-system in the absence of more definite knowledge concerning the transmission of force between æther and matter, if the use of such a phrase is permissible.)

Prof. Duhem points out that Maxwell, in obtaining his first estimate of the velocity with which electromagnetic waves are propagated,[2] confounds Lamé's coefficient of rigidity with one of his own, which is really double the former, and that on correcting this mistake a velocity is obtained which exceeds that of light in the ratio of $\sqrt{2}$ to 1. This work of Maxwell's is, however, generally regarded as containing only the germ of a theory of light and as indicating that the two velocities concerned are of the same order of magnitude.

The author concludes by lauding the electrodynamic theory of Helmholtz, which he regards as satisfactorily reconciling the electromagnetic theory of light with the ancient theories of electricity and magnetism.

It is surprising to find no reference whatever to Larmor or to H. A. Lorentz in the historical sketch of this branch of the subject.

Although some of the mistakes pointed out by Prof. Duhem are real and important, the view taken throughout, as will be gathered from the above, appears a very narrow one.

W. McF. ORR.

OUR BOOK SHELF.

Clinical Pathology and Practical Morbid Histology. By J. Strangeways Pigg, M.A. Second edition. Pp. 107; 5 plates and 6 figures. (London: Strangeways and Sons, 1901.) Price 5*s.*

THIS is a small interleaved handbook for use in the laboratory, dealing with the different methods employed in examining blood and other normal and pathological fluids and morbid tissues.

The descriptions of the various methods referred to are brief and concise, and the steps of each operation are tabulated in exact sequence, with perhaps the exception of 24, D, where steps 6 and 5 should obviously be transposed. Objection may be raised to such an arrangement as being too dogmatic and allowing no scope for individual ingenuity, but, on the other hand, those who have to deal with large classes of students, to whom the book is chiefly directed, will agree that some such method is absolutely necessary if one would instil the principles underlying good technique.

The general "get-up" of the book is good; there are very few printers' errors save an occasional missing letter at the end of a line, or the interpolation of a letter from another fount of type. "The illustrations," we are told, "are diagrams only," a description obviously applying to those of apparatus and urinary sediments—which latter, by the way, would have been more useful had they been bound up in somewhat closer proximity to the letterpress relating to them—but hardly fair to the two coloured plates of blood-cells. These are, in spite of their accuracy, beautiful and artistic, and reflect nothing but credit on artist and lithographer.

[1] *Phil. Trans.* 1897, A. p. 248.
[2] "Scientific Papers," vol. i. p. 500.

The methods set out in the text are, for the most part, well chosen and well described; those dealing with morbid histology are, however, by far the most successful. In blood work, we notice, the author recommends Cabot's "two-cover-slip" method of spreading films—a method which in the hands of experts yields, perhaps, 10 per cent. of stainable specimens—and quite ignores the simpler method introduced by Manson, in which gutta-percha tissue or a piece of cigarette paper is employed.

We notice, too, in the preparation of cover-glass films from pus or sputum, that extremely dirty and slovenly method of pressing out a small portion of the material between two cover-glasses and then sliding them apart, is given as the usual method. We hope that this is not the universal practice in Cambridge laboratories.

The sections dealing with bacteriological methods and urinalysis are certainly disappointing—in the latter the methods are few in number and, in our opinion, not always happily chosen, whilst fuller indications of the fallacies which attend some of the tests would have enhanced their value. In that portion dealing with bacteriological investigations, many of the methods might find favour in the clinical laboratory, but would certainly be *taboo* in the well-regulated bacteriological laboratory. We notice, too, that the author invariably uses *Carbol*-gentian-violet in staining by the method he terms Gram's; it is true the actual stain is easier to prepare, but its results are decidedly inferior to those yielded by the Anilin-gentian-violet originally described by Gram.

As we have before mentioned, the book is intended for the medical student, and as such is of distinct value, a fact sufficiently evidenced by the success with which the first edition has met

The Balancing of Engines. By W. E. Dalby, M.A., B Sc. Pp. xi + 283. (London: Edward Arnold, 1902.) Price 10*s.* 6*d.* net.

THIS work is of a character which can be studied with interest. It deals with a subject of great importance to mechanical engineers, and one which is coming more and more to the front in the design of high-speed engines and machinery.

Prof. Dalby is the author of several papers dealing with this important subject, read before the Institutions of Naval Architects and Mechanical Engineers; these papers are largely drawn upon in the present volume.

"The main object of the book is to develop a semi-graphical method which may be consistently used to attack problems connected with the balancing of the inertia forces arising from the relative motion of the parts of an engine or machine." This we learn from the preface, and, what is more, it requires nothing but the knowledge of the four rules of arithmetic and good draughtsmanship to apply satisfactorily the methods so well described.

The balancing of the working part of locomotives has always been treated from different points of view, and the practice of a particular drawing office largely governed the result; in fact, not many years ago an eminent locomotive engineer looked upon the balancing of his locomotives as an unnecessary addition to their weight.

Chapter iv. deals with this very important subject in a clear, concise and practical manner, and even only for this one chapter all interested in locomotive design should possess this volume. The author advises that those interested in locomotive work should begin chapter iv., after working the examples of arts. 48 and 49, progress being tested by working the exercises at the end of the book.

The treatment is simple, several types of Lancashire and Yorkshire Railway Company's locomotives being taken as examples, and little thought will be necessary to carefully follow the threads of the argument. The experimental apparatus described to illustrate the

various problems of locomotive balancing is very interesting, appearing to thoroughly fulfil the conditions.

Prof. Dalby has produced a book useful alike to the mechanical engineer and the student. N. J. L.

Guide to Italy. Pp. civ+352+4. Price 10*s*. net.
Guide to the Western Mediterranean. Pp. xxvi+238. (London: Macmillan and Co., Ltd., 1901.) Price 9*s*. net.

IN adding one more series of guide-books to those already in existence, the publishers have struck out in a somewhat new line by making conciseness their most important feature. The overworked professional man, who has little time to read up lengthy descriptions, will here find, condensed into a smaller compass than has previously been done, the most important points to be looked out for on his proposed journey. The authors of these books have been remarkably successful in condensing so large an amount of information into them.

The "Western Mediterranean" is divided into sections dealing respectively with Lisbon, Andalusia, Morocco, Algeria, Malta, Naples, the Riviera, the Balearics, and other ports and districts of interest. In "Italy" a different and novel order has been adopted. The book opens with articles on Italian life, art and architecture by "O. B." and other well-known writers. Next comes a description of routes *only*, without lengthy descriptions of towns; lastly, the towns of Italy are described in alphabetical order. The advantages of this method may not, perhaps, impress the reader at a first glance, but as soon as he is accustomed to the new order of things he will become converted to the belief that the system effects a considerable saving of time and trouble and is most convenient. Hotels are enumerated in a list by themselves; in a future edition the authors might with advantage make an effort to give fuller information under this head, especially in reference to tariffs. There are also a few minor points on which opinions may differ. Most Italians know an "Inglese" fast enough and do not take every foreigner for a Frenchman (p. xii.); in the vocabulary (p. xvi.), "entrate" is a more familiar equivalent for "come in" than "avanti"; and if the authors of "Italy" are *really* right as to the situation of Virgil's tomb (p. 147), Neapolitan guides and cab-drivers have been wrong for many years. The maps are excellent.

Outlines of Electrochemistry. By H. C. Jones. Pp. vi + 106. (New York: The *Electrical Review* Publishing Co., 1901.)

THIS is an exceedingly interesting book. The title is, perhaps, a little misleading. To our mind it would be better to call it "Physical Foundations of Electrochemistry," or some similar title. There is an inclination among writers of electrochemistry to treat the subject entirely from the physical standpoint, hence many books on the subject lack breadth of treatment. The present book, as the author explains in the preface, is a republication of papers which originally appeared in the *Electrical Review* (New York).

Chapter i. deals with osmotic pressure in a very clear and lucid manner. Chapter iv., on the "newer theories of electrolysis," is very ably written, and here Mr. Jones, in explaining the theory of the electrolysis of water containing acids, alkalis or salts in solution, adopts the theory of Le Blanc, which looks upon the electrolysis of water as being a *primary* and not a secondary reaction. Most writers explain the electrolysis of water as being of a secondary nature, due to the presence of the acid or base in solution. According to Le Blanc, it is entirely a question of the decomposition value of the water, and of the salts, acids or bases in solution. In an aqueous solution of an acid, for example, it is simply a question whether the ions of the acid or those of the water will the more readily give up their electrical charges, it being assumed that pure water is slightly ionised.

Chapter vi., which is divided into two parts, deals with the "conductivity of solutions," and a very interesting lecture experiment, due to Noyes and Blanchard, for showing the different conducting powers of various electrolytes, is described. A good deal of attention is devoted to the dissociating power of different solvents, especial stress being laid upon the dissociation of electrolytes in alcohol. Mr. Jones does not, however, refer to the fact that certain inorganic salts are considerably ionised when dissolved in pyridine. In this connection it is interesting to notice that quite recently Kahlenburg has succeeded in depositing lithium in the metallic form, from the solution of its chloride in pyridine.

Mr. Jones is to be congratulated upon having presented us with a very readable and scientifically written account of the foundations of electrochemistry. We notice that the author is engaged upon a work on physical chemistry, the production of which we await with interest.

F. M. P.

Outlines of Botany. By R. G. Leavitt. Pp. 272. (New York: American Book Company.)

THIS book has been compiled for use in high schools and is based on Asa Gray's "Lessons in Botany," an abridgment of his well-known standard work on plant morphology. The author points out that he is not in agreement with the strong ecological bias developed in so many recent American text-books, and that he has endeavoured rather to develop the study of structure and form, and also to emphasise the physiological factors which control plant life. This view will be endorsed by many botanists.

The method adopted is to suggest a series of practical studies, each being followed by an elaborated theoretical discussion. The principle involved of setting the student to learn by direct observation depends firstly on the student and secondly on appropriate treatment of the subject. For advanced students such a course might be admirable. But for students at high schools there is neither the requisite time nor training required for such investigations; for these introductory lectures are absolutely necessary. Then again, as regards his treatment of the subject, one must entirely differ from the author. The first chapter, dealing with seeds and seedlings, will illustrate the objections to be raised. Beginning with the gross features of the castor bean, lupin and maize, the author next proposes a series of physiological exercises—*e.g.* the nature and location of food reserves; absorption of oxygen, production of carbon dioxide and heat evolved in germination; geotropism and development of chlorophyll. He then returns to morphology to give a brief summary of special morphological features. It will be observed that on the one hand the training to be gained by a well-balanced and varied series of anatomical exercises seems to have been overlooked, for the castor bean does not offer a favourable object for a first investigation, and at least eight or ten seeds should be examined. On the other hand, the physiology is too varied. What teacher with practical experience does not know the many difficulties and pitfalls which attend even simple experiments? What success may be expected for a young and inexperienced investigator who attempts these broadly-extending exercises, with the help of descriptions which are often extremely vague? Throughout the chapters dealing with the flowering plant there is the same paucity of development and want of judgment in choosing anatomical exercises. The book contains a cryptogamic course which is somewhat superficial, and closes with two unsatisfactory chapters on anatomy and physiology.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

The Permeability of Iron Alloys.

In a paper in the last number of the *Proceedings* of the Royal Society, Prof. Barrett refers to the increased permeability conferred on iron by alloying it with aluminium, and suggests an explanation on the supposition that the aluminium would remove traces of oxygen from the iron.

Some seven years ago, in the course of a series of measurements on the magnetic properties of iron alloys, I found that aluminium, phosphorus and arsenic decreased the coercive force and hysteresis loss very considerably, whilst aluminium very largely increased the permeability—the others less so. Silicon produced little effect, but probably slightly improved the iron. On mentioning this to my colleague, Prof. Arnold, he at once pointed out that these elements are just those which increase the size of the crystals in iron. Annealing, which also improves permeability and lessens hysteresis, also increases the scale of the crystals. It is probable, therefore, that the increase of permeability due to these substances is a secondary effect due to the increased size of the iron crystals. A foreign substance might be expected to act deleteriously in two ways: (1) by occupying space better filled by iron, (2) by combining with iron and forming a less magnetic chemical compound. Phosphorus and silicon would act in both ways, aluminium in the first only, which might account for a larger difference between its indirect favourable action on the iron crystals and its direct deleterious action. It would be interesting if investigators in this direction would try to correlate their permeability measurements with the results of microscopical analysis as well as chemical. W. M. Hicks.

University College, Sheffield, April 10.

Reform in Mathematical Teaching.

Some of Prof. Perry's followers seem to me to miss a point which he realises clearly—viz. that the key to the whole position is in the examination system.

(1) The strength of the present system is very great. An impending examination converts the teacher from an enemy of the idle and refractory pupil into an ally—to the comfort of all parties. The success of his pupils at examinations gives a teacher some return for his labour; otherwise he would have to comfort himself by hoping that Kipling's great lines, "Therefore praise we famous men," might some day in some degree apply to him. The realised hope would be worth ten thousand times the immediate return, but hope deferred is discounted at very heavy rates.

(2) The present system might be very much better. Examining work is often badly paid; in the main and in the long run, bad pay means bad work. Thring said that you might have one generation of martyrs, but the second would be cheats.

The band of fossil examiners, each with his fossil syllabus, does much more harm than Procrustes. A is clever, but he must not go beyond the syllabus; B is slow, but he must be bustled along and got through the course somehow.

The fate of anything new or fresh is pretty sure. There is a Cambridge yarn about some one who set his favourite question, "Define a differential coefficient," but instead of getting the expected three or four lines of cram, he got the substance of five or six pages of Harnack's new German book on the calculus. He rose to the occasion and promptly marked it 0.

(3) But written examinations have inherent and inevitable defects, clearly indicated by Dr. Lathom "Examinations considered as a means of selection." The old style of question, which was rather reproduced than parodied by the famous "Very small elephant whose weight may be neglected, and whose coefficient of friction was $\sqrt{7}-\sqrt{3}$," may be replaced by "The relation between the weight and length of tusk of an elephant being represented by the equation $W=Al^3+Bl+C$," and so on . . . but a system of written examinations based on the new model would in the end be like unto the first.

The following axioms are put forward in the hope that they may be condemned as truisms:—

(1) Examinations are not to be multiplied beyond necessity.

(2) No examination is entitled to any confidence in which teachers or persons in close touch with the teachers have no part.

(3) *Viva voce* examinations are essential if weight is to be attached to the results of a single examination.

It would be most interesting if Prof. Perry, who has influence and persuasiveness, could arrange an experiment.

Get answers to a paper from a dozen candidates, good and bad mixed, have facsimile copies made, and submit them to twenty or so competent examiners. The discrepancies in the marks would, I think, be surprising.

If the examiners adopt the received plan of cutting each question into several bits and giving marks for each little bit, they will get results more concordant and more entirely out of relation to common sense or real life. C. S. Jackson.

Woolwich.

There are two places in Prof. Perry's letter appearing in your issue of March 27 in which he mentions schoolmasters in terms of, in the one case praise, in the other blame. The first passage is where he congratulates the "reformers" "on having with them the good wishes of every thoughtful teacher of the whole country," but in the last passage he expresses the conviction that we shall "not very long remain in the foremost files of our time if we depend upon the schoolmasters." I hope that teachers are good for more than mere good wishes, and I think Prof. Perry will find that the reform he laments as scarcely within sight has not only begun, but is actually bearing fruit in the place in which, though the subject of controversy, the noise of the conflict is heard least—the schoolroom. Schoolmasters, like others, move with the times, and the "conventional schoolmaster" is a much rarer bird than the conventional examiner or the conventional inspector. I suppose syllabuses and text-books are a necessity still, but the competent teacher of mathematics needs not to be bound by anything of the kind. Personally, I see no necessity for this ideal text-book one hears about which is to replace Euclid, and those who caricature him; we are better without a text-book at all. Let a master be engaged capable of making his own syllabus for his own pupils, and give him a free hand to introduce modern geometry, differential calculus, &c., as he sees fit; such a man will welcome the appreciation of a competent inspector, himself a mathematician and, beyond that, a successful teacher of mathematics. As I have already hinted, reform in the schoolroom proceeds as rapidly as examiners will allow, rather more so in fact, for I know that many boys learn much that no examination they have been in for, or are likely to take, tests. My own work is in such a small way that I do not care much to bring it forward, but I must confess to periods of guilty satisfaction when I have robbed time from examination teaching and introduced boys, much to their interest, and I feel sure profit, to such things as coaxal circles, theory of inversion, cross ratios, and fundamentals of the integral calculus. Let the mouse help the lion!

I feel sure Prof. Perry and his fellow reformers—if they will find out what is being done on the spot by the teachers, or if the latter have as yet shrunk from any sort of attempt at reform, what their wishes and opinions are—will find convention at least as hateful to the teachers as to themselves. Of course, I am not speaking, as I am not qualified to speak, on behalf of those who form what I may term the "aristocracy" of the teaching profession; I myself and my teaching friends are mostly engaged in the small schools, large in number, situated in industrial districts, where the endowed school fights for an existence with the "technical" or even the higher-grade Board School, where boys leave between fourteen and sixteen, at the latter of which ages they are supposed to have the groundwork on which a knowledge of engineering can be built up. Yet to these Euclid must be taught. Of course, as a matter of fact, Euclid is not taught to them; they pass examinations in a subject that goes by that name, the satisfaction I personally have felt being in the reports of examiners, who, intending to reprove, have written, "the constructions and principles of proof were well known, but the wording of Euclid was not adhered to, and some points in the proofs were omitted. The riders were well done." In these schools, "practical plane and solid geometry" is a subject taught throughout; and there is many a germ which only requires a little encouragement to bear great fruit. I think that the power behind the reformers

may be even more potent than it is reckoned. With associations growing in influence, and the great facilities afforded for exchange of ideas, the body of teachers is very rapidly increasing in strength, and this reform in the teaching of mathematics, together with many another much-needed reform, is perhaps much more in the immediate future than is thought. At any rate, if the bow and arrow is still the official weapon, the use of the magazine rifle is being secretly taught, and we school teachers look forward with no misgivings to that great fight. Prof. Perry sees ahead for our people, rather we are "spoiling for it," for with it will come our freedom!

FRANK L. WARD.

1 Macdonald Place, Hartlepool, March 29.

Rearrangement of Euclid Book I., Pt. i.

IN answer to Prof. Lodge's letter I should like to say that we have for some time followed much the order he suggests. Euclid's order unnaturally separates propositions which should come together, *e.g.* I. 4, 8, 26, and is, therefore, a serious hindrance to a clear grasp of the subject-matter as distinct from mere exercise in logic.

The following order—substantially that suggested by Prof. Lodge—seems natural, and we have certainly found it work very well in practice.

(1) The propositions on angles, viz. 13, 14, 15, 27, 29, 32, cor. 2, 32. At this stage logical deduction from definitions and axioms is difficult and, to a boy, unconvincing. The following proof of I. 32 cor. 2 is convincing, at least: "If a man walks right round a rectilineal figure (starting and ending at a point in the middle of a side), he turns once round. Hence the exterior angles, which are the angles through which he turns, are together equal to 4 right angles." Similar proofs of 27 and 29 are equally convincing. Any attempt to analyse these proofs into the axioms on which they depend seems to me at this stage foolish; it is work for a highly trained and speculative mind, not for a boy.

(2) Triangulation, I. 4, 8, 26.

These are, I think, best presented as the outcome of experience passing into intuition, and as special cases of the general fact that three data are necessary and sometimes sufficient to determine a triangle. The special case of right-angled triangles with hypotenuse and one side given should be added and proved deductively from I. 5.

The rest of Book I. consists of exercises on these fundamental propositions:—Properties of a single triangle, I. 20, 5, 18, 6, 19; loci; quadrilaterals; areas. The order in which these last three subjects are taken is immaterial.

A special advantage of this arrangement is that it makes it easy to combine practical with theoretical work. It was, indeed, from the attempt to do this that we were led to follow this order, but even in purely theoretical work it has proved a great gain.

As to the omission of "constructions" from the deductive course, we agree—they are properly treated as exercises.

As to the effect of this change on real progress we have no doubt. As to examinations, we hope that they will before long (1) permit freedom in the order of propositions, (2) diminish bookwork and insist upon riders and practical work, as some, indeed, already do.

It seems illogical, but even in deserting Euclid's order we adhere to his numbers. The constant reference to cardinal propositions is a great help to thoroughness and clearness of knowledge, as well as to ease of questioning and answering. Probably no one will ever succeed in fixing fresh labels on to the propositions, and for the present at least we find the old ones useful, though they are to our boys quite arbitrary.

W. C. FLETCHER.

Liverpool Institute.

I QUITE agree with Prof. Alfred Lodge as to the order of propositions he proposes, which is practically the order I adopted in my "Foundations of Geometry." But he does not in his letter refer to what seems to me the chief reason for it, which is that the elementary geometry of straight lines and angles should precede the geometry of plane surfaces, including any propositions about areas. And to carry out this idea, the fundamental propositions which Euclid gives so badly in his XIth. book (props. 1–9) ought to be taken before such propositions as his I. 35 and 36. On the other hand, there are important propositions in the XIth. book, notably prop. 10 (if this is not included in the definition of parallelism) and props. 20 and 21, which come properly in what Prof. Lodge calls the first part of Book I.

By the way, I may mention that it seems to me illogical to prove I. 27, as Prof. Lodge does, by a simple "which is impossible," and to refer I. 29 to "Playfair's axiom." Neither proposition is nearer *a priori* truth than the other, and it is just as easy to disguise the difficulty, if you wish to do so, in either case.

EDWARD T. DIXON.

Racketts, Hythe, Hants, April 14.

WE have had the following arrangement of Euc., 1–32, in use for three years with more than two hundred pupils. 13, 14 (from the definitions); 15; 32, cor. 2, 32, 16, 17; 23, 8, 9; 4, 10. Locus of a point equidistant from two given points. 11, 12, 5; 26, 6. Locus of points equidistant from two intersecting straight lines.

This gives fourteen propositions; thirty-seven more complete all the plane geometry of Euc. I.–VI. and XII. required in mathematics or science. We have no superposition "proofs"; they merely obscure obvious truths. Parallels by superposition have been found beyond the capabilities of beginners. Why not alter the definition? At present it gives the least obvious property of parallels.

A caution to the professors who are teaching us how to teach. We are seeking a system of geometry suitable for boys of ten, and the most logical method is not necessarily the best; it is better to separate 4, 8, 26 by examples of their use and to leave the remaining case for trigonometry. Again, an ideal course must be inventional, and must grow out of practical work; therefore it must introduce problems as early as possible: a beginner should not be allowed to quote a construction which he cannot perform. Is not the demand for a purely theoretical course due to a desire to use 1, 9, in proving 1, 5, whilst retaining Euclid's proof of 1, 8?

T. PETCH.

Leyton Technical Institute, April 14.

IN reply to the appeal of Prof. Alfred Lodge for opinions with reference to his proposal to alter the sequence of Euclid's propositions by introducing those relating to parallels at the earliest possible stage, permit me to express what I hold to be insuperable objections to his proposed innovation.

Whatever other objections may be raised to Euclid's sequence of propositions, it at any rate has this distinguishing merit, that it separates the propositions (I. 1–28) which are independent of the postulate of parallels from those which are true only when that postulate is admitted. To obscure this distinction, as, for instance, by treating props. 16, 17 as corollaries of prop. 32 and so appearing to depend on the postulate of parallels, would to my mind, especially now that the non-Euclidean geometry of Lobatchewsky and others is an established part of mathematical science, be a distinctly retrograde step.

Further, this innovation is not in the least necessary to secure Prof. Lodge's object (with which I entirely sympathise), namely, a better and more natural grouping of the propositions about triangles.

For this purpose all that is necessary is to add I. 16 to the three (13, 14, 15) with which he proposes to begin. This proposition may at once be proved as follows:—

The triangle being A B C, the side B C produced to D and E the mid-point of A C, turn the triangle A E B about E until E A comes on E C and A on C, then E B comes to a position E F in the same straight line as B E, and since B E F, B C D meet in B. they cannot meet again, so that F lies on the same side of B D as A [N.B., here comes in the difference between plane and spherical surface geometry], and E C F or the angle A is less than the exterior angle A C D.

This proved and I. 17 as its corollary, the propositions about a single triangle and those about the comparison of triangles easily fall into a simple and natural sequence and grouping.

Shanklin, April 12.

ROBT. B. HAYWARD.

Winter Phenomena in Lakeland.

THERE being no record within my knowledge as to whether holly and ivy are starch-trees or fat-trees, *i.e.* as to whether their wood-starch disappears or otherwise in winter, a strict watch was set upon the phenomena. During the months of December, January and February, sections were taken at

intervals of the twigs and smaller branches of these trees, and their content in starch was carefully tested and observed. The general result was that the ivy is a decided starch-tree, inasmuch as at no time during the winter was its wood found free of starch or anyway nearly so. No doubt, as compared with summer, there was a great diminution of this substance, many of the medullary ray cells being completely empty of granules, and moreover, *e.g.* on January 18, only about one-quarter of these cells were stored with starch, and even this gave a reddish-brown tinge to iodine, as if amylodextrin was intermixed therewith. As regards the holly, there could be no question that the amylaceous reservoirs of its wood had suffered a still more serious depletion. Nevertheless, they were never found completely void, a more or less considerable accumulation of starch granules being readily distinguishable along some portion of the medullary rays; the pith, too, was never empty (that of the ivy was found invariably depleted). It may be added that in both cases starch was completely absent from the bark during the winter months.

The overthrow by the boisterous gales of the departing year of a crab-apple that was perched aslant on a sharp ridge of rock afforded an opportunity for observation of the root appanage of this tree. The wood of the root contained a considerable amount of starch, but none was found in its bark. The alcoholic and aqueous extracts of the latter proved very rich in phloridzin, the reactions thereof being yielded with eminent distinctness and beauty, and the phloretin prepared from it indicated by its behaviour in alkaline solution with nitroprusside of sodium that it was a fatty aromatic ketone. Phloroglucin was detected in the wood, but none in the bark.

Whilst exercising on the hills on January 19, numerous faded and embrowned brackens were seen which a week or so previously had been overlaid with a thick mantle of snow. The fronds of one of these were incinerated, and the crude ash was found to contain no less than 43·6 per cent. of silica, also 13·2 CaO and 0·8 phosphorus (or 1·8 P_2O_5). This enormous amount of silica is all the more remarkable, inasmuch as in August the ash of the fronds contains only about 9 per cent. of this constituent and that of the stem about 7 per cent.—the difference is doubtless to be attributed to the very considerable diminution of the soluble salts, and not of the lime, during the course of autumn. In this case, as in that of all calcifugous species, a strong proportion of lime in the young and vigorous frond would offer a serious obstacle to the presence of a considerable quantity of potass. Thus, on June 3 the amount of potass and soda in the ash is somewhere about 32 per cent., in August 27 per cent., and in late autumn about 2 or 3 per cent. The lime, on the other hand, fluctuates from about 6 to about 13 per cent. only, and thus while in a great many leaves the autumnal deficit is, so to speak, covered by lime, here in the case of the bracken it is refunded by a lavish plethora of silica. The general inference is that the frond, having been utilised as a support for the reproductive parts (sporangia), the strain thereby involved leads to a very advanced condition of decay, whence a tremendous drainage of silica towards the organ. Perhaps it is this very faculty of remaining decayed without disfigurement, encased in silica, that is one of the causes why abundant remains of ferns are found in the fossil state.

Patterdale, Westmorland. P. Q. KEEGAN.

The Species Problem in Corals.

MAY I direct the attention of your readers to an exhaustive article, dealing specially with "species" among the reef-corals, by Prof. Döderlein in the current number of the *Zeitschrift für Morphologie und Anthropologie*? It is somewhat hard to find myself there blamed for continuing to use the word "species" in relation to a group in which it is totally inapplicable, for I laid the whole subject before the Linnean Society a year ago. I stated the difficulty and suggested a provisional alternative method of designating specimens. I carefully explained that I was proposing a method of work in order that we might discover the true species by gradual arrangement of the variations. In the autumn of the same year I made a brief statement at the International Congress of Zoologists in Berlin, but the report has not yet appeared; and again, later in the year, I read a paper before the Cambridge Philosophical Society. This has appeared in the last number of the *Proceedings* of that Society under the title "On the Unit of Classification for Systematic Biology."

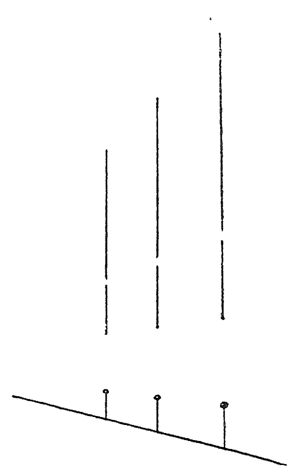
It will be noticed that while Prof. Döderlein discusses the general problem very fully, he makes no practical suggestion as to how to designate the different forms for reference. I, struggling with nearly a thousand foolscap pages (dealing with three genera) for the "Catalogue" of the Great National Collection of Corals at South Kensington, was compelled to invent some way of labelling them. But before finally adopting it, I sought the advice of many of the leading zoologists and botanists within reach. HENRY M. BERNARD.

Clapham, S.W., March 21.

Sun Pillars.

ON January 19, 1901, during zero weather at Winnipeg, Manitoba, the fine icy particles which floated over the city as a cloud at 11 a.m. gave a halo round the sun with two mock suns to the right or left at the same altitude as the sun, and above the halo an inverted arc of about 120° showing prismatic colours. There was a good deal of wind at the time.

At night the wind dropped and the air became very still. The haze of icy particles descended, and in the middle of the night its illumination by the strong arc lamps of the city gave a column of light, comparable to a sun pillar, extending above each lamp to a height estimated at 300 feet. A striking feature of the phenomenon was the perspective effect, the columns diminishing in apparent height in such precise proportion to the increasing distances of the street lamps that it was evident the upper surface of the cloud of particles was truly horizontal. At this time the vertical columns of light were also visible below the lamps and extended to within a few feet of the ground. A few hours later, viz. at 4 a.m. January 20, the lower ends of the columns were more than 60 feet from the ground, and therefore far above the lamps.



They extended to a height of about 300 feet, as judged by the distance of the nearest lamp and my elevation above the ground, which was about 60 feet. A narrow rift extended horizontally through the cloud, breaking each column of light into two parts. The figure is re-drawn from a rough sketch made at this time of the columns above three, only, of the numerous arc lamps.

The slight haze of minute icy particles which is common in zero weather is, I believe, called *poudrette* in Eastern Canada

VAUGHAN CORNISH.

Swarm of Velella.

ON a former occasion while sailing in the Mediterranean I have noticed the abundance of this beautiful Hydro medusa, usually known as the "Portuguese Man-of-War," sometimes distributed over the surface of the sea, but never in numbers such as have been stranded along the northern shores during the past few days.

When taking my usual morning bathe at Mentone on April 5, I plunged into a living mass of these Siphonophora, which extended many yards from the shore. It was about the same on the 6th, when I gathered a number and preserved them in formol (5 per cent. from the 40 per cent. solution). Since then the shore has been literally strewn with them, a very disagreeable odour being emitted. At Bordighera yesterday and here to-day, nearly fifty miles from Mentone, their dried remains strew the shore and appear to be well preserved, though, of course, minus their beautiful colour. We have had no strong south winds, and I cannot see how to account for so remarkable a shoal. ISAAC C. THOMPSON.

Alassio, April 9.

Resultant-Tones and the Harmonic Series.

THE following method of recovering, by inspection of the harmonic series, the position of the differential resultant-tone of the first order for any given musical interval has occurred to me, and, as far as I have been able to learn, has not yet found a place in the text-books on musical acoustics which are in most common use. I therefore venture to hope that a brief statement of it may gain admittance to your columns and be the means of saving some time and trouble to students of the subject.

The harmonic series up to No. 10, with the order of each number placed below it, may be written thus:

C	C′	G′	C″	E″	G″	(B″♭)	C‴	D‴	E‴
1	2	3	4	5	6	(7)	8	9	10

the brackets of course indicating that No. 7 is not identical with the seventh note of the diatonic scale. As the "vibration numbers," or "frequencies," of these harmonics are proportional to their respective order-numbers, these latter may, for the purpose in hand, be treated *as if they were the vibration-numbers* of the corresponding harmonics. Hence the difference between any two order-numbers will give the vibration-number of the resultant-tone for the interval formed by the two corresponding harmonics, and the position of the resultant-tone in the harmonic series will thus be at once assigned.

Successive application of the above method to a series of intervals gives the following results:—

Minor tone D‴ – E‴, $10-9=1$. Resultant tone C, 3 octaves and a major tone below the graver primary.

Major tone C‴ – D‴, $9-8=1$. Resultant tone C, 3 octaves below the graver primary.

Minor third E″ – G″, $6-5=1$. Resultant tone C, 2 octaves and major third below the graver primary.

Major third C″ – E″, $5-4=1$. Resultant tone C, 2 octaves below the graver primary.

Fourth G′ – C″, $4-3=1$. Resultant tone C, a twelfth below the graver primary.

Fifth C′ – G′, $3-2=1$. Resultant tone C, 1 octave.

Minor sixth E″ – C‴, $8-5=3$. Resultant tone G′, major sixth below the graver primary.

Major sixth G′ – E″, $5-3=2$. Resultant tone C′, fifth below the graver primary.

Octave C – C′, $2-1=1$. Resultant tone C, coincident with the graver primary.

Ninth C″ – D‴, $9-4=5$. Resultant tone E″, a major third *above* the graver primary.

In order similarly to treat semi-tones, sevenths and other dissonant intervals, it is only necessary to include higher numbers of the harmonic series, and the method is evidently as applicable to summational as to differential resultant-tones.

MARGARET DICKINS.

Tardebigge Vicarage, Bromsgrove, April 5.

Municipal Meteorology.

IN your notes in NATURE for April 3 (p. 518) you mention Dr. H. R. Mill's observations as to the length of the February frost, the period at Torquay being reported the shortest, viz. nine days.

I think it should be pointed out that for scientific purposes the Torquay temperatures should be treated with much caution, as those of an extremely sheltered spot, viz. Cary Green. Up to last year Torquay had two observing stations; but one of them, viz. that at Chapel Hill, was given up. On moving the adoption of the report advising, among other things, the discontinuance of the said station, a member of the Town Council very honestly remarked that "the range of temperature at Chapel Hill was greater than that at the Princess Gardens, and it was *more satisfactory for the town* to have as small a range of temperature as possible"! (*Western Morning News*, March 6, 1901). According to the last meteorological report, the temperatures are still taken at one of the old stations, viz. Cary Green. The differences between Chapel Hill and Cary Green were often considerable, *e.g.* on March 18, 1900, Chapel Hill 23°·9, Cary Green 27°.

A. R. HUNT.

Torquay, March 10.

A Gall-making Cynipid Fly in Jamaica.

THE Hymenopterous gall-makers of the family Cynipidæ, though widely distributed over the earth, have seemed to be totally absent from the West Indies, somewhat to the astonishment of entomologists. However, in February, 1892, Mr. W. Harris sent me a gall on *Bidens reptans*, collected by Mr. Nicholls at Cinchona, Jamaica. The gall was a large oblong swelling attached to the stem of the plant, and contained many cells. Unfortunately, I was not able to breed the flies, but I secured some immature fragments, which sufficed to show that they were Cynipidæ. Mr. W. H. Ashmead, to whom I submitted my notes and sketches, is of opinion that the genus must be Aulax or allied thereto. Although it is impossible to determine the species, it seems desirable to call attention to the occurrence of this gall-maker in Jamaica; and perhaps one of your West Indian readers will be able to supply us with complete information.

T. D. A. COCKERELL.

East Las Vegas, New Mexico, U.S.A., April 3.

Criticism of "The Great Persian War."

MAY I call attention to one or two points in your critic's treatment of my work (p. 434)?

(1) Your critic says that at Thermopylæ "the mound and the Phocian Wall are the only debatable points."

I may mention that, among many other debatable points, some persons who have examined the pass have located the fight at the West gate.

(2) Your critic is apparently not aware that the site of Trachis is uncertain. Two sites at some distance from one another have been proposed.

(3) Of Aphetæ he says, "it is hard to reconcile Mr. Grundy's situation with the remark of Herodotus, that the wreckage of the first sea-fight drifted *out* (the italics are your critic's) to Aphetæ, which is badly misrendered in the words 'was thrust in upon the Persian fleet.'"

Either your critic or Liddell and Scott are guilty of a bad mistake in scholarship (*vide* L.S. sub. ἐκφορέω. 4. Pass, "to be cast on shore": with a reference to this very passage Herod. VIII. 12; *cf.* also ἐκφέρω in the same dictionary). If I sin, I sin in very good company.

(4) In reference to B.C. 479, your critic asks, "Why should they (the Persians) stop at Cithæron?"

I would ask in reply, (1) Why did not the Persians stop in Attica? (2) Why, above all, did the Greeks follow them into Bœotia?

(5) Your critic says, "It is absurd exaggeration to call Taurus 'an all but blank impassable wall.'"

In the part of that chain which separates Asia Minor from the Euphrates region between the pass from Laranda to Kelenderis and the pass of Kiskisos, a distance of 170 miles, there is only *one* pass, the Cilician Gates. The two first mentioned afford circuitous and difficult routes to the Euphrates region. The Cilician Gates are by no means an easy pass. (For Map *vide* Ramsay, "Asia Minor," p. 330.)

(6) Your critic says that "for downright geographical nonsense" it would be hard to beat the description of Pteria as the chief strategic point in the Halys region, as commanding the middle portion of the valley through which the river flows.

He is apparently under the impression that in order to command a valley strategically, a town must be in it. On the importance of the position of Pteria the evidence of Herodotus is sufficiently striking (H. I. 76), "Now Pteria is the strongest position in the whole of this country."

(7) Your critic asks, "Are the Phrygians and the Bithynians still to be called Thracians in the days of Darius?"

His answer is obviously No! Another authority, Herodotus, however, speaking of the races which Crœsus ruled, mentions (I. 28) Θρήικες οἱ Θυνοί τε καὶ Βιθυνοί.

(8) Your critic says, "On p. 378 a whole paragraph is based on a childish mistranslation of Herodotus."

This charge is based on a somewhat careless mistake of his own. I speak of a "decision." He refers to the "discussion" of chapter lxxiv. of Herod. VIII.

I have dealt with all the major charges brought against me. I cannot expect you to allow me space to deal with the minor charges, though I believe them to contain inaccuracies.

G. B. GRUNDY.

THE EDUCATION BILL.

THE Education Bill introduced by the Government on March 24 has been so freely discussed in the public Press that everyone interested in educational work is familiar with its chief provisions. The fundamental idea is the creation of local bodies to supersede School Boards, managers of voluntary schools and technical instruction committees, and to be responsible for the organisation and maintenance of the various educational agencies—both primary and secondary—within their respective areas. The local education authority will be the County Council in counties and the Borough Council in county boroughs; it will work through committees appointed under schemes to be approved by the Board of Education, consisting of members appointed by the County and Borough Councils, with a minority of persons possessing expert knowledge of educational work. The committees will thus be similar to those under which the work of technical education has been carried on since 1889.

In the contributions by Dr. Oliver Lodge, Sir Joshua Fitch and Prof. Wertheimer, which are subjoined, several aspects of the measure are described. It will be evident from these articles, and from the views which have been expressed elsewhere by persons and organisations whose opinions merit attention, that the principle of local educational authorities meets with general approval. But it is apparently impossible for primary education to be considered in England without raising religious difficulties; and the controversy over this subject is of such an uncompromising nature that it threatens to delay or wreck the present measure as it has others.

The abandonment of the Bill would, in our opinion, be a disaster to education in England, for the measure represents an earnest attempt to put our educational system on a sound organic basis. The only way to avoid such a disappointment seems to be to divide the Bill into two parts—one concerned with secondary and the other with primary education—and let each part be dealt with as a separate measure. Secondary education includes technical education, and national progress depends more upon the coordination and extension of these higher stages than upon elementary instruction. What the country needs are masters and managers educated in the truest sense of the term, men with scientific training and sympathies, able to appreciate latent possibilities of industrial developments and anxious to encourage all work which aims at the advancement of knowledge. It is in students of this class that England is lamentably deficient as compared with Germany and the United States, and it is to such students that the country must look for material progress.

We ought not to have to wait for a settlement of the differences of theological parties before organising the agencies for higher education, which have fortunately been emancipated from these difficulties. The Bill as a whole is a comprehensive measure which could be made an Act of decided value to education, but as there seems little hope of removing the opposition to the part dealing with primary education, the sections dealing with secondary education, which are less contentious and are generally accepted, should be separated from it and passed first. The local authorities which would thus be created would then be able to gain experience, and perhaps in the course of time public opinion would be intolerant of the interference of sectarian parties with schemes for secular education. To permit such differences of opinion to delay the establishment of higher education on a sound basis would be a national misfortune.

EDITOR.

I.

The opposition threatened to the Education Bill just introduced by Mr. Balfour may or may not be weighty, but it is voluminous enough to demand some activity and energy on the part of those who realise the immense leeway in secondary education that has to be made up, and who welcome any real and public-spirited attempt to grapple with the difficulties of its effective organisation.

It is unlikely that the new Bill is free from faults, but it clearly represents a strenuous and conscientious effort to legislate in the right direction; to many it appears a statesmanlike attempt to grapple with the numerous difficulties and at the same time to leave as much opportunity as possible open for local experiment, for growing experience, and for the subsidence of needless hostilities; and in any case it should be welcomed by all who are interested in educational progress. For though they may not be able to approve every minute detail, yet the more they study it, the more they will realise the care and forethought which have been exercised in steering through the maze of conflicting interests and in endeavouring to lay down the wisest course.

The form of educational government which has most promoted rapid development and has shown itself to be extremely well qualified to adapt itself to new requirements is the kind of government which controls University colleges. The success and growth of these institutions has been the prominent educational feature of the last quarter century, and they are governed by a council consisting of local business and professional men, not specifically qualified—qualified highly in other directions,—who have sufficient public spirit to give some time and trouble to the work; this body, the council, is advised and assisted in all academic matters by the professorial staff in subordinate conclave, who form a body called the senate, which has no financial power, but has usually in practice, by reason of its special interest and knowledge, a very considerable guiding influence. The business man, when properly advised on technical matters, but only when so advised, is extremely expert as an organiser and conductor of affairs on common-sense lines; he is usually far more efficient in these respects than the academic officers themselves; and the combination of the two works admirably.

The system which has proved so effective may well be extended so as to take control of the schools also. Something like it is what the Government propose. The real education authority is to be the County or Borough Council, an assemblage elected for general purposes, and containing, it is to be hoped—certainly containing in all places where local self-government has been a credit and an inspiring example—the best and ablest of the citizens. It is vital that the best and most competent men shall consent to serve in this capacity, and everything which increases the interest and the dignity of the proceedings of such bodies is to be welcomed. But though each County and Borough Council is the ultimate authority, with power of purse, subject only to the central Board of Education which may be said to take the place of the Court of Governors of a University college as court of appeal and general supervisor, it is not to be the working administrator. This is to be a committee appointed by the Council, together with other persons who may be nominated by representative institutions, and may include experts in education of all kinds; and this administrative body will roughly correspond with the senate, and will have much power, but it must contrive to act so as to carry with it the conviction and the support of the local education authority itself.

The precise constitution of this committee is left undecided by the Bill—a feature which has excited hostile

comment—and the county authorities are asked each to draft and submit a scheme to the Board of Education, so as to allow as much local initiation as possible. This and many other provisions of the Bill may seem, to persons who come new to the subject, as a needless opening of the door to variety and difficulty; but the more we appreciate the different circumstances obtaining in different localities throughout the country, and the more we discuss the matter with representative men who have been connected with official educational matters in the past, the more does some such course seem desirable.

A series of private conferences was held in the University of Birmingham during November 1901, and was attended by a specially invited number of representative educationists, prominent members and officials of School Boards, managers of voluntary schools, and other men of experience and various views, representing opposite schools of thought; and at these conferences a general idea of the provisions which would be likely to secure practical agreement was arrived at. I propose in this article to summarise them and to indicate how far and in what way the Government Bill satisfies the conditions then laid down as most suitable.

First, there are three general conditions which any effective Bill should satisfy, and on which there was universal agreement:—

(A) That all education shall be included in the purview of the education authority so as to secure continuity of the educational system throughout the country.

(B) That the new authority should be sufficiently strong and independent of sectional interests to deal effectively and impartially with educational defects in its district, whoever is responsible for them.

(C) That it should be provided with prompt and efficient means of obtaining funds, both imperial and local, for carrying out its policy; that it should have proper borrowing powers; and likewise the power of compulsory purchase of sites.

To these may be added a fourth, which, though it touches upon controversial topics and when pressed into detail could easily excite difference of opinion, yet in its general form will probably be accepted by all fair-minded men:—

(D) That while insisting on a minimum of efficiency and on representation on the boards of management of all schools drawing assistance from national or local funds, the new authority should recognise the value of the voluntary schools to the nation, and do nothing to discourage the interest of religious bodies in the education of the people.

Next it seems to be quite widely and generally accepted that a unification of educational organisation is desirable, so as to break down the strict line of demarcation between primary and secondary, to raise the status of the primary teacher, and to open a career and the highest educational posts to competent men who enter the profession even at the lowest grade. It is also generally accepted that this general education authority should not be central, but be local; so as to spread the interest, to adapt itself to varying conditions, and to secure the many advantages of distributed local self-government. This was expressed in the first resolution:—

(1) That there should be one local Education Authority, which should control all the educational agencies receiving public support in the district—primary, secondary and technical—and should get into effective contact with institutions for higher education, such as non-local or endowed schools, University colleges and Universities.

But the difficulties begin as soon as it is attempted to lay down a constitution for the new authority. There are many who advocate that one uniform constitution should be laid down in the Act. Others hold that it would be better to let each locality consider what is best for itself, and to have at least the option of formulating a scheme, to be approved and sanctioned by the central authority or Board of Education; but that no scheme should be drafted by that body except in cases where the locality did not choose to exert its power of choice. Although there would be a certain disadvantage in having different schemes simultaneously in force in different places, yet it is likely that each County Council would take more interest in and would take more pains to work a scheme that they themselves had had a hand in drawing up, rather than one which had been forced upon them, in which they had no voice, and might feel that they had no responsibility for its success or failure. Again, it appears difficult to say of any scheme that could be suggested that it is absolutely the best. It may be necessary to ascertain the best by actual experiment, and if different places adopt somewhat different schemes, the best of them may before long emerge and may hereafter be imitated elsewhere. At any rate, the majority of the conference was in favour of some local option in this matter, and adopted the following clauses:—

(2) That each County Council and each County Borough Council, either separately or in combination with other neighbouring councils and with representatives from adjacent boroughs, and in consultation with some recognised educational experts, shall formulate a scheme for the constitution of the Educational Authority in its district, and shall submit it to the Board of Education; subject to the proviso that no scheme is in general likely to be acceptable which does not provide:—

(*a*) That about two-thirds of the suggested Education Authority shall consist of members in some way or other elected by ratepayers of the district (though not necessarily elected for the specific purpose of education).

(*b*) That a reasonable proportion (say in general about one-sixth) of the suggested Education Authority shall consist of members nominated by specified educational institutions of weight and influence in or near the district.

(*c*) That the remainder shall be co-opted according to some scheme to be submitted.

(*d*) That place shall always be found, in one or more of the above classes, for women on each educational authority.

(*e*) That the members of the Educational Authority, whether co-opted or nominated or elected, shall retire in rotation, say one-third every three years or one-half every two years, but shall be eligible for re-election.

Note.—A minority held that it was undesirable to leave even this amount of experiment and variety to local option, but that a uniform constitution should be enforced in the act.

(3) If no scheme is formulated by a County Council, the Board of Education shall formulate one.

(4) Any scheme for the constitution of a local authority, however formulated, shall be published in the locality, and criticisms considered, and petitions heard against it, before confirmation and adoption.

The Government Bill differs from these clauses in the following particulars:—First and most important, it is not the authority itself which is to be thus constituted, but only the working committee; next, the Bill does not dictate to the County or Borough Council in what way it shall formulate a scheme which it shall submit for approval to the Board of Education; and, lastly, there are only two provisos laid down, which, however, embody the essence of the above provisos *a*, *b*, *c*, except that, instead of two-thirds, a majority only is insisted on, and this majority need only be elected by the ratepayers at second-hand, being appointed by, but not necessarily themselves being members of, the council. In practice, however, no doubt a large number of them would be actually elected members of the council. In practice also it is to be hoped that proviso *d* above would always be enforced, for since half the children to be taught are girls, it is only a matter of common sense that place for women should be found on each education authority; and it might have been wise to attract support by definitely inserting this provision. But this and the business arrangements about retiring are left as part of the optional scheme to be drawn up by the various localities; indeed, the whole proposals of the

Government tend in the direction of leaving as much liberty and elasticity as possible, having faith in the county authorities to devise a suitable scheme without coercion from Parliament. This feature, it seems to me, should be welcomed except by persons who have no faith in popular government.

But there is one important item in the Government Bill which was not adopted by the above-mentioned conference, and which appears certain to excite the hostility, and which evidently has excited the hostility, of members of School Boards, though the reasons why they object to it do not lie on the surface. This is a matter on which much controversy turns, and it may be as well to explain it.

In the above proposals of the conference it was all along assumed that the committee appointed to work the educational scheme would be itself the education authority, and the following additional clauses with regard to its financial powers were drawn up :—

(5) That the Education Authority as constituted be an authority subject only to the Board of Education, that it have independent rating power, borrowing power and purchasing power, and be not regarded as a committee of the County Councils with proceedings subject to revision by those bodies.

Note.—Whatever objection may be felt to this independence of rating power for educational purposes, it is felt that if it were not granted the incipient harmony and agreement would be destroyed, for the School Boards would not willingly consent to resign an important portion of their powers to any but a strong and autonomous education authority.

(6) That the local authority shall administer and apportion all public educational funds ; of which it is desirable that a larger proportion than at present should be derived from imperial revenue (since the local rate falls with undue severity on the poorer districts, and for other reasons), and that no limit be placed by Act of Parliament on the rating power for education of a local authority.

But here the Government Bill differs entirely; it constitutes the County Council itself the local authority and gives it full control of the purse (subject, however, to certain limits of rating power, which limits are too absurdly narrow as specified in the Bill, though a means of widening them is provided, for any education higher than primary) ; and the working education body is only a committee of this local authority, consisting of appointed, co-opted, and nominated members. The object of this contrivance is manifest, viz. to leave the ultimate financial control entirely in the hands of persons directly elected by the ratepayers, and to get rid of the anomaly of two independent rating powers. But there at once we touch upon the jealousy or rivalry which has existed between the County Councils and the School Boards, for the latter are not likely to be willing to give up their powers to a body elected for other purposes than education, the members of which are not necessarily even members of the education committee ; nor are they likely to willingly resign their financial autonomy in favour of a mere committee without rating power. This has always been recognised as one of the most difficult points about the Bill, and it is not likely that any solution would meet all objections. On the whole, the Government solution seems to me ingenious and hopeful, but they must be prepared to face a genuine conflict of opinion on this point. Fortunately, the urgency of the conflict is mitigated by the optional provision which permits efficient School Boards to continue for a time ; but the option does not rest with the School Board—it rests with the County Council ; and this fact, though probably unavoidable, may lead to conflict. On the whole, it appears not unlikely that this provision for choice between adoption and non-adoption of the elementary education portion of the Bill may be abrogated ; but strong arguments in favour of it are given below (see paragraphs following 14).

The next four propositions are little more than business arrangements, though it may be convenient to quote them. They are as follows :—

(7) That financial support be not granted to any institution until proper means be taken to secure its effective expenditure.

(8) That any existing powers whereby a locality aids an educational institution nominally outside its area shall be preserved.

(9) That it shall be the duty of each local authority to forthwith examine into the educational need of the district, to report to the Board of Education both on its present supply and from time to time on the further additional supply necessary, and, subject to control and approval by the Board of Education, to take steps for its provision.

(10) A right of appeal to the Board of Education on behalf of any aggrieved institution shall be conceded.

Of these it is satisfactory to find that No. 8 is included in the Bill, so that, for instance, a University college which manifestly serves an educational area without being actually located in that area, can as heretofore be assisted by the council controlling the area.

It is to be feared that No. 10 does not find a counterpart in the Bill. Right of appeal to the Board of Education as an arbiter is given in connection with primary education, but it is needed on behalf of any institution, though not of any individual, which feels itself aggrieved by some action of the local Education Authority.

Then there arises the question as to the proper size of an educational area. It would be desirable, if possible, that each complete area should contain an example of every grade of educational institution, from the primary school to the college and University. This is not feasible, but what is feasible is that for certain purposes some common action could be taken, or some amalgamation effected, by areas which are educationally too small. Moreover, there are many instances where the administrative county area will turn out very artificial for educational purposes, giving rise to much needless overlapping ; and, although it would seem impracticable to mark out new areas, yet even that might be permitted if locally desired ; anyway it would be quite feasible for county authorities to combine for educational purposes, and accordingly the conference adopted the following resolution :—

(11) That local Education Authorities of adjacent districts which for any reason have educational interests in common be empowered to combine, to discuss, and to appoint joint committees for all such purposes as may be common to their areas ; and likewise, if they choose, to combine altogether or amalgamate for educational purposes, so as to constitute a large educational area administered by one authority ; and that facilities for such combination be afforded.

Note.—Opinion was divided as to whether it was feasible to enforce combination among administrative counties for educational purposes, with the object of securing a large dignified and comprehensive educational area.

The essence of this desideratum is provided for in the Act in an ingenious manner, the arrangement of an education committee not itself a County Council facilitating the matter, because plainly county authorities could combine to work their districts by a single education committee nominated conjointly.

The educational standing of non-county Boroughs and urban districts has been a matter which has always given great trouble and excited considerable controversy.

A non-county borough with a large population, for which it has made considerable educational provision, and possessing a penny rating power for technical instruction, would resent being treated by a County Council on the same lines as the surrounding rural districts ; and yet it seemed difficult to constitute so small a body with no great variety of schools in its area an actual Education

Authority. Accordingly the conference adopted the following resolutions :—

(12) That it be exceptionally permitted to some boroughs and urban districts in the neighbourhood of county boroughs to link themselves for educational purposes with the said county borough by mutual agreement instead of directly with their proper county.

(12*a*, supplementary to 12) Any Borough or District Council with general rating power shall be empowered to levy an additional rate for education in its own boundaries over and above that demanded by county authority from the entire area of which it forms a part; but this rate shall not be expended by the Borough or District Council until its recommendations have been submitted to, and approved by, the Education Authority in whose area it is situated.

The Government Bill solves the difficulty in a somewhat analogous but still more liberal manner —some think an over-liberal and unwise manner;—the Borough Council itself, when it represents more than a certain population, is constituted the local Education Authority, but it is given the option, not only of sharing, but actually of transferring, the responsibility, either the whole or a part, to a County Council, provided the latter is willing to take it, and at the same time its independent rating power for education higher than elementary is preserved.

It is to be hoped that the power of amalgamation between neighbouring counties, boroughs, and urban districts will be exercised; for this question of the size of an administrative area is really a very important one. Many eminent persons hold that an area the size of a Province would be in many ways better and more dignified than the present area of an administrative county: a return, as it has been called, to the heptarchy, the natural provinces of which were marked out by physical features, and have always retained a certain set of common interests. These ancient provinces are large enough to support highly dignified governing bodies, to which a great part of the local government still at present cumbersomely and expensively administered at Westminster could with propriety be transferred, thereby setting free the time of Parliament for Imperial purposes, and leaving local questions connected with locomotion, drainage and the like to be dealt with by the localities which most thoroughly understand them. It is just possible that amalgamation for educational purposes might form the beginning of this much-to-be-desired result.

Returning now to the business arrangements which must be made by an education committee, it is manifestly desirable that the authority for a large area shall not attempt actually to manage the schools in its area, but shall operate on them through Managers more immediately in contact with each school, such a board of managers being in most places already in existence, and being therefore conveniently continued, though with some modification.

The following resolutions were adopted by the conference, and similar provisions are included in the Bill:—

(13) That the Education Authority, though having control over all schools dependent on public funds, shall not constitute itself a board of management for any school; but shall provide that managers be appointed or continued for every school or group of schools within its area, according to some scheme approved by the Board of Education.

(15) In order to establish and maintain connection between the managing bodies and the local Education Authority, the latter shall nominate one or more persons to serve on each managing board or governing body concerned with any school or group of schools deriving financial benefit from rates or taxes.

(16) That in order to facilitate connection with and representation from the local authority, existing non-elected managing bodies be combined with one another for purposes of administration, on lines similar to those in use under the Aid Grant Act of 1897.

But it is desirable that those specially appointed managers who represent the controlling body shall report to that body regularly. Otherwise the control might gradually cease to be effective.

I have omitted No. 14, which had to do with the future of the more efficient School Boards—those which had done good work and had gained the confidence of the community, and which it seemed undesirable to suppress. It was a very difficult point, and no satisfactory solution was arrived at. The resolution may be quoted, in order to emphasise the difficulty; and it was drawn in vague terms in order to cover, not only School Boards, but the boards of all other schools which are to be affected by the Act.

(14) That existing administrative educational bodies, wherever they have shown themselves efficient, be continued in their office and function as managing boards, and in such dependence on popular vote as already exists, and with their present attendance authority, but without rating power, and subject to the control, as hereafter defined, of the local Education Authority.

What the Bill proposes, however, is not this poor compromise; it proposes to leave it optional with each locality, at any rate for a time, to decide whether the existing School Board shall continue to take control as heretofore of primary education, or whether it shall be at once superseded by the new and comprehensive authority. Perpetuating the School Board system in places will have the effect of perpetuating there the undesirable dislocation between primary and secondary education; but, on the other hand, it will avoid introducing sudden disturbances; it will allow the present conditions, wherever efficient, to persist for a time; it will allow business to continue during alterations, and it will pave the way for a gradual change on to the new lines when time and experience are ripe. Hence it appears to me that this optional clause, permitting the transfer of primary control to be locally delayed for a time, is to be distinctly welcomed as affording an easy and elastic means for introducing the provisions of the Bill with the consent of each community, rather than forcing them to accept them prematurely. Ultimately it is to be hoped that but little conflict will arise between School Boards and County Councils on this matter, because no County Council would be foolish enough to overlook the advantage of nominating the prominent and efficient members of School Boards on to the new Education Authority, thereby continuing to reap the benefit of their wisdom and experience, just as they will continue the Board officials in practically their present office and function.

Those who advocate the abrogation of this optional clause, and the compulsory forcing on each County Council of full and immediate responsibility for primary as well as for secondary education, would do well to remember that voluntaryism is the essence of local government in England; and that if a body is overweighted, or prematurely loaded, people of judgment may decline to serve on it. Compulsory adoption of the Act would logically involve a measure to enforce service on a County Council.

The vexed question of how to improve and give rate aid to the schools provided by religious denominations, and of what special privileges can be conferred on such schools in return for certain pecuniary sacrifices made by the denominations interested in them, has excited, and will no doubt continue to excite, much controversy; but, as it seems to me, controversy of a belated kind, more noisy than effective, and largely maintained by those who have lived through the sectarian controversies of 1870. To the younger men these sectarian difficulties loom very small;

it is felt to be fair that if a religious denomination provide and keep a school in effective order, it should have the power of giving its specific instruction during certain limited hours, arranged so that scholars not belonging to that denomination may be withdrawn at the wish of their parents; and it is felt to be unfair that the secular instruction of the children in the district which such a school serves should suffer by reason of deficient funds owing to sectarian jealousies; it is felt, in fact, that the district can be properly called upon to support such a school in as thorough a manner as any other, provided always that the ratepayers' authority be extended (*a*) to a voice on the managing board in accordance with the above resolution No. 15, and (*b*) so that it shall have an effective voice in the appointment and dismissal of teachers. Accordingly the following resolution, together with the "powers and functions" numbered 3, 4, 5, 6, 7, below, was adopted, and practically represents what is, or may be under a "scheme," provided by the Bill; except that very unfortunately the word "dismissal" has escaped explicit mention. It may be held to be legally included in the word "appointment," but it is a vital matter to get security of tenure for all teachers, and not leave any of them at the mercy of individual action unchecked by the Education Authority.

(17) That a school whose buildings are the property of a religious organisation, by whom they are maintained to the satisfaction of the local Education Authority, shall be regarded as a privileged school in which special religious instruction is permitted at certain hours, in accordance with a time-table to be submitted by the managers to the Education Authority for its approval, and subject to the conscience clause of the Act of 1870.

Note.—A small minority considered that the upholders of these privileged schools, managed by non-elected bodies, though under the control of an elected educational authority, should be called upon to provide one-sixth of the income in addition.

It is desirable, however, and it may be feasible, to introduce a clause giving to other denominations, which are not providing a school, if they are in sufficient numbers and if there is no other school in the neighbourhood, to make application, not only for mere withdrawal of their children from the specifically denominational religious instruction provided, but, in addition, for the supply of general Biblical teaching for those children to attend in the same school at some other hour.

This question of the so-called voluntary schools—which is a misnomer, the proper title being denominational schools or privileged schools—is by no means an insignificant one, since more than two-thirds of the schools in the country are of this kind; and if they were not taken advantage of, it would not only be a blow to educational and humanitarian enthusiasm, but it would involve the ratepayers in enormous additional expense. At present these schools are suffering from extreme poverty, the voluntary contributions and the Imperial grant together being quite inadequate for their proper maintenance; and the buildings themselves are often inadequate, antiquated and unwholesome. With rate aid and proper control of teaching appointments, no longer leaving teachers subject to the caprice of an accidentally injudicious local clergyman, educational efficiency can be secured; and the denominational subscriptions will still be required, in some places even more than hitherto, in order to put the fabric into a satisfactory condition and to maintain it in substantial repair, as required by the Education Authority. If they do this, the denominations cannot be expected to do more, and they are entitled to give specific religious instruction at certain hours on the strength of this. But if they go further than this in their demands for rate aid, if they resent any element of popular control—resent, for instance, any interference with their appointment and dismissal of teachers, or any influx of nominated members on to their managing board, that is to say, if they resent effective control of their rate-aided secular instruction—they will be taking an unwise course, and must not be surprised if the clauses in the Bill, which already give them everything to which they are reasonably entitled, are opposed so strongly as to be modified in a direction opposite to that which they desire. It is undoubtedly the interest of Churchmen, meaning by interest, not selfish interest, but public and denominational interest, to support the Bill; but the unwisdom of some few of the letters which have appeared in its support is extreme.

The last resolution adopted by the conference, having reference to the training of teachers, unfortunately has no corresponding clause in the Bill. It ran as follows:—

(18) That Education Authorities shall be empowered to enter into relations with Universities and University colleges and other institutions for higher education, in order to make provision for the proper training of teachers; and that after a certain date special sanction should have to be obtained for the employment of unregistered teachers.

But it is to be hoped that the omission has no real significance, that operations for the training of teachers will be in every way encouraged, and that it was only omitted because of the inadvisability of loading the Bill, or the duties of the new Education Authorities, with more than was absolutely necessary.

This represents all that I need now say on the general subject. The remainder of what the conference did was to draw up a specification of the "powers and functions" of the committee, stating in what way it should exercise control over the schools in its area, and what was meant by "control." It may possibly be useful to County Councils and other bodies engaged in formulating a scheme if these be here quoted; but it may be remarked that the first two are perhaps somewhat doubtfully wise in their present too unrestricted form.

Specification of powers and functions.

The functions and powers of the local authority shall be:—

(1) To keep a register of the efficient schools in the area, and to transfer schools and endowments from places where they are not wanted to places where they are.

(2) To make orders for the use of endowments or other grants, for establishing scholarships from schools to other schools or to colleges and Universities. and

(3) To inspect all schools in its area as to buildings sanitation, and publicly aided schools as to educational efficiency, and to make regulations in accordance with the reports of its inspectors.

(4) To withhold financial aid from any school and to close any publicly aided school which fails to comply with its regulations or which is educationally inefficient.

(5) To frame a scheme to be submitted for approval to the Board of Education for the remodelling, when necessary, of the constitutions of existing publicly aided schools, and for providing new schools.

(6) To receive and consider the curriculum of each publicly aided school, as submitted by the board of managers; to amend and refer back any part of such scheme; and ultimately to approve the curriculum adopted, having regard to the educational needs of the district.

(7) To receive and consider recommendations of the managing board concerning the appointment and dismissal of teachers in the schools under its management, and to be the final court appeal in such matters.

(8) "Control" shall mean the exercise of any of these powers.

Oliver Lodge.

II.

The Bill recently introduced by Mr. Balfour is a complex measure, carrying with it some consequences which are not apparent at first sight. Many of its clauses—notably that which makes the adoption of

some of its provisions voluntary on the part of the County Councils—will doubtless be subject to much criticism and to many amendments in detail before it passes into law. Meanwhile it may be useful to review the chief features of the Bill, as they affect (1) technical, secondary and higher education, and (2) the public elementary schools.

Part II. of the Bill follows in the main the line indicated in the former Bill of 1896, which was withdrawn by the Government of that year. It gives to each council of a county and of a county borough, and to the council of any other borough with a population of more than ten thousand, the name of the "local education authority," and empowers it to supply or aid the supply of education other than elementary. The Technical Instruction Acts of 1889 and 1891 are repealed, and with them disappears the definition of "technical instruction," which has practically restricted the application of funds under those Acts and under the Local Taxation (Customs and Excise) Act to technical and scientific instruction. The local education authority of the future is therefore set free to allot its revenues to advanced instruction in any form which the circumstances of the district need, whether scientific, commercial, literary, technical or manual, or whether, as is more probable, the secondary schools include in their programmes all of these forms of instruction in varying proportions. This is a clear gain; the Bill may, it is to be hoped, encourage the formation of a sounder public opinion respecting the true scope and purpose of a liberal education, as distinguished from the specific preparation of the student for any one form of practical or industrial pursuit. Since in another part of the Bill (clause 18) evening scholars and scholars above the age of fifteen are excluded from the elementary schools, and presumably from a share in the ordinary Parliamentary grant, it may be inferred that, in addition to the existing grammar and endowed schools, and technical and secondary schools generally, all the higher-grade and continuation schools, and evening schools now controlled by the School Boards, will come into the domain of "higher education" and will receive aid only under the provisions of Part II. of the new Bill. Beside these, it is to be assumed that the local education authority will have under its care the training colleges for teachers, the pupil-teachers' central classes, and the management of local scholarships and of such endowment funds as are applicable to education in their respective districts.

The resources available for advanced education under all these forms will be drawn from the fees of the scholars, from the whole residue of the fund generally known as "whisky money" and provided by the Local Taxation Act, and from a rate which is not to exceed twopence in the pound in counties and county boroughs, or a penny in the pound in non-county boroughs. It is manifest that these resources will not suffice to fulfil all the purposes just enumerated, and will leave little chance for the establishment of such new schools or colleges as may be needed, or for any adequate organisation of secondary instruction in the whole country on a generous scale. Moreover, it is to be observed that the new educational authorities will be only "committees" of the County Councils. They will have no power to raise rates or to give effect to their own recommendations, but will act in all respects in subjection to the veto of larger bodies, which are chiefly concerned with county business, with the water supply and with gas, tramways and sewage, and will be strongly tempted to keep down the rates and to give to the interests of education a subordinate place. It may fairly be concluded that the measure of the Government, if passed in its present form, will have the effect of repressing rather than encouraging educational enterprise, the expansion of existing institutions, the establishment of new ones, or the trial of new experiments.

This serious defect in the constitution of the local educational authority becomes more evident when we consider its probable influence on elementary education. At present the School Boards, which are the popularly elected administrators of the public funds available for elementary education in a given district, are under no restriction as to the local contributions to be levied in the form of rates, and are responsible only to two superior authorities—the ratepayers who elect them and the central Board of Education at Whitehall. Under the proposed measure, the managers of schools will be placed in relation to three authorities—the Board of Education, the County Council and the nominated Committee. It is difficult to see what can be gained in administrative efficiency or in unity of educational purpose by this arrangement. The measure will certainly check the ambition of "educationists" who are busy in discovering new methods and increasing the usefulness of the schools, and in effect it will encourage local authorities to prefer economy to educational improvement. As to the Board of Education—hitherto known as the Education Department—its policy of late has been to abdicate many of the most important functions which it once discharged to the great advantage of the public. Until lately it set up standards of excellence, and sought by graduating its grants to secure that these standards were attained. It has in recent years deemed it better to relieve itself of all attempt to discriminate between good, bad and indifferent schools, and has declined to examine the scholars and has awarded practically the same grant to all schools alike. It now proposes to leave to school managers the responsibility of framing such schemes of instruction as will satisfy the local public, and of seeing that these schemes are carried into effect. Thus between a central Department which is ceasing to exercise more than nominal control and a County Council which may chance to consist of persons hostile or at least indifferent to the intellectual progress of the people, or are else absorbed in county business of another kind, our principal safeguards for such progress, which have hitherto been found in School Boards elected *ad hoc*, and presumably caring most of all about the credit of their own town and the goodness of their schools, will be seriously weakened. It is impossible to look forward without grave misgivings to the future of popular elementary education in England under the new conditions contemplated in the Bill.

But, after all, the true significance and the obvious *motif* of the measure are to be sought elsewhere. Its best friends do not claim that elementary education under the new conditions will become sounder, larger in its scope, more scientific in its methods, or nobler and loftier in its aims. They advocate it chiefly because it will bring relief to the supporters of voluntary schools, especially to those of the Established Church. It is well to recall the actual facts of the present situation. About half of the children under instruction in England and Wales are taught in Church schools, owing to the fact that in the rural districts there is generally but one school in the parish and that the parents have no opportunity for exercising a choice. In towns, however, where such an opportunity exists, the Board Schools are generally fuller and more popular. Out of a total expenditure of nearly thirteen millions of pounds upon elementary education, the Church of England contributed last year about six hundred thousand pounds, in the form of subscriptions, congregational collections, and grants from local endowed charities. For this sum the representatives of the Established Church secured the sole management of schools attended by more than two millions of scholars, and the full power to give distinctive theological teaching and to administer the schools in the interests of the Church. To a plain man this arrangement appears to be an excellent bargain, from the point of view of those who regard those interests as supremely important. But it is always described in diocesan conferences,

episcopal charges and religious newspapers as a gross injustice and an "intolerable strain" upon the benevolence of Church people. Accordingly, the Government has been urged by the advocates of the denominational principle to make two concessions by way of relief: (1) to increase the public grant so as to make all voluntary subscriptions unnecessary, and yet to leave the existing managers free to preserve the distinctive denominational character of their schools, and (2) to repeal that clause (the fourteenth) in the Education Act of 1870 which forbids the teaching of creeds and formularies in the Board Schools, and so to permit the ministers of religion to give separate instruction in those schools to the children of their respective flocks. Both of these proposals were accepted by the Government and embodied in the abortive proposal of 1896. The second, however, does not appear in the new Bill. The Cowper Temple clause is not repealed, but will still remain applicable, not only to all existing Board Schools, but presumably to all new elementary schools to be provided by the proposed education authority. But to the former of the two demands, the Bill makes a liberal response. Denominational schools are to be financed and supported in future at the expense of the rates, on the easy condition that the managers provide and maintain in repair the school building—not, it should be observed, the furniture and equipment—and shall continue to maintain it as a Church school, subject only to the proviso that a number of members of their body, not exceeding one-third, shall be nominated by the local authority.

It will be seen from a careful study of the Bill that its dominant purpose, so far as regards elementary education, is to encourage the multiplication of denominational schools, to remove the "intolerable strain" of maintaining them from the shoulders of the churches to those of the ratepayers, to strengthen the denominational system and to give it a renewed chance of permanence. It may be that this great change in the national policy will commend itself to the approval of the English Parliament and people, but its meaning should not be misunderstood. It was the prayer of the Greek soldier, "Let me die in the light," and if, after all our experience and the efforts of statesmen to make our system of public instruction more national and less sectarian, we are really destined to see that system impaired if not destroyed, we ought at least to have our eyes open, and to see clearly what is the nature of the present reactionary movement and whither it tends.

J. G. FITCH.

III.

The two main causes for the relative poorness of British technical education as compared with that given in Germany and the United States are, (*a*) the fact that comparatively few British manufacturers have as yet learned the need for the efficient technical training of those whom they employ, and (*b*) the chaotic condition of the secondary, and part of the elementary, education of this country.

The Government Bill is a step towards the rectification of the latter defect, for not only does it make possible some organisation and improvement of secondary education, but it also tends to secure greater efficiency for the denominational elementary schools, many of which are at present in a starved condition.

Most of those connected with technical education will be glad to see that the Government has chosen as its educational authority a body on which, while the representative element will rightly predominate, there will be a minority of educational experts. Evening classes will come under the control of this new authority, and it will be possible to grade them properly and to secure that the bulk of the money spent upon them is not frittered away in simply giving many thousands a mere smattering of knowledge. At present this is the case to a considerable extent, and one reason for it is the lack of proper coordination between evening classes in Board Schools and higher institutions; such coordination would encourage a much greater number of the Board-School pupils to continue their studies to a stage when these studies might prove of real benefit, not only to the pupils, but also to the nation.

The Bill has two serious defects, both of which, however, can be easily remedied. In the first place there is the optional clause, which leaves it to the various county and borough councils to decide whether or not they will make themselves responsible for the whole of the education in their districts. If this stands it is certain to perpetuate old difficulties and to give rise to a whole series of new ones; it is to be hoped, therefore, that the Government will stiffen its back and leave no option in regard to this important matter.

Secondly, there is no clause in the Bill which appears to safeguard the interests of technical education by ensuring that the residue under the Local Taxation (Customs and Excise) Act, 1890, shall continue, as heretofore, to be devoted to the purposes of technical education. It is of great importance that this should be specifically enacted, as otherwise there will be a danger that, in view of the increased demands upon the ratepayers for improved elementary and secondary education, the local authorities may curtail the sums they now expend on technical education, though those sums are still inadequate when compared with the sums spent by our leading industrial competitors.

Finally, it would be well to include in the Bill some provision, not only for the coordination of work within the district of each local authority, but also for the coordination by means of the central educational authority of the work undertaken by the local authorities themselves. This is particularly necessary in the matter of technical education, for, if we are to have technical colleges which will be comparable in efficiency with those of the United States of America, we must gather large numbers of students into a relatively limited number of centres, and provide in each centre the best possible equipment and a teaching staff on a scale much more generous than in any example at present to be found in Great Britain. Elementary technical education ought, of course, to be given as far as possible in all parts of the country, but the attempt of small towns to give the highest technical education to few students should be discouraged. These students should be drafted into centres, and the determination as to where these centres should be placed should be left in the hands of the central educational authority. Moreover, higher technical education being a matter of more than local importance should be subsidised, not only, or mainly, by local authorities, but very largely by the State itself. One may hope for such increased State aid at present, but it seems scarcely justifiable to expect it; our statesmen have yet to learn that expenditure on an army and a navy to keep the "open door" for our commerce will not suffice to enable us to meet foreign competition, unless we expend time and money on the training of our industrial and commercial leaders in the same liberal and enlightened manner as is the case in the foremost foreign countries.

J. WERTHEIMER.

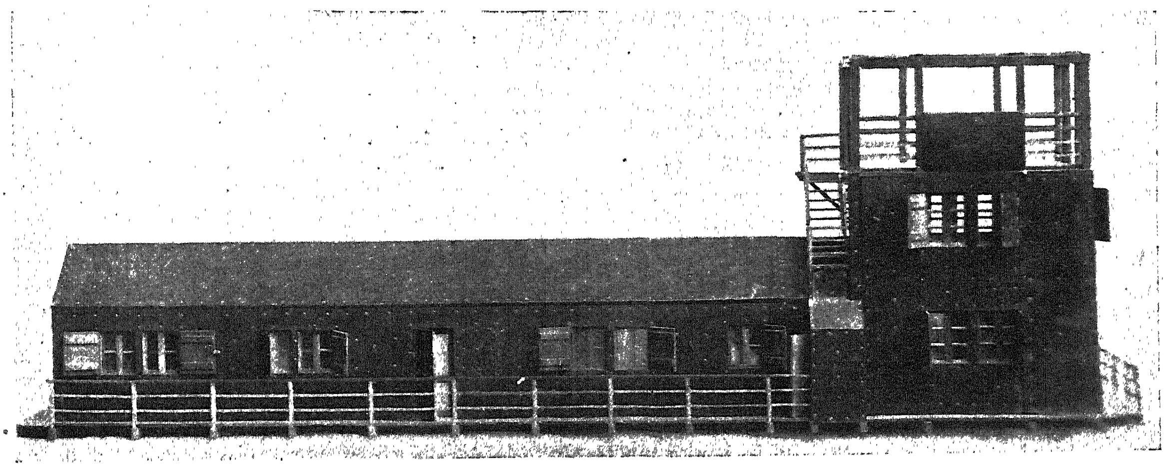
THE REGINA MARGHERITA OBSERVATORY.

THE investigation of the physiological phenomena which present themselves when man ascends to high altitudes is as fascinating as the results are, or promise to be, important. The fascination and the importance are connected with the complexity of the problems which have to be dealt with. The effect on respiration due to the diminished oxygen of the rarefied

air, so far from being the one thing to be studied, as the casual observer might suppose, is perhaps not even the chief thing. Of still greater importance, probably, are the manifold effects of diminished pressure on all the tissues and organs of the body, on the vascular system in all its parts, peripheral and central, and the far-reaching secondary results of the changes in the circulation thus brought about. These are further complicated by the influence of variations in temperature and in the qualities of the sun's rays.

It is through their complexity that the problems in question hold out so much promise; for they carry us beyond the mere question why such or such physiological incidents occur during a high mountain ascent, they lead us more or less directly to fundamental matters of physiology.

To solve these problems two things are needed—the possession of exact instruments of precision, and the opportunity of making use of these instruments at ease and with freedom from disturbance. The observations necessary to solve the problems which we have now before us cannot be satisfactorily conducted by means of rough instruments carried in the pocket, and cannot be adequately made in the open while the observer, blown about by a cutting wind, is steadying himself on his ice-axe. Happily, both these needs can now be supplied to any competent observer whose inquiry justifies the concession of them.



The Regina Margherita Observatory. The first room to the left of the two-storied part of the Observatory is the physiological laboratory.

It was a happy thought of the Dowager Queen Margherita of Italy, whose love for the Alps is known to all the world, to convert into a scientific observatory the Regina Margherita Hut, which stood on the Gnifetti Peak of Monte Rosa at an altitude of 4560 feet, and which had proved of such service to mountain climbers. At her spontaneous suggestion, and by her beneficence, assisted by the Italian Government and with other help, the Hut, largely through the zeal and activity of Prof. Angelo Mosso, of Turin, has been transformed into the Regina Margherita Observatory, fitted up for scientific observations of various kinds.

Prof. Mosso is a physiologist, especially interested in the physiological problems of high altitudes, as shown by his book "Life of Man on the High Alps," and it is through his care that in the Regina Margherita Observatory, in addition to the provision for meteorological, astronomical and other physical observations, physiology has not been neglected. One of the rooms has been set apart for physiological observations and experiments. The great benefit thus rendered to physiology was acknowledged at the International Congress of Physiology held at Turin in September last under the presidency of Prof. Mosso. On the motion of Prof. Bowditch, of Harvard University, it was unanimously resolved to recommend the physiological laboratory forming part of Regina Margherita Observatory to the International Association of Academies as worthy of international support.

Nor was this the only token of approval shown at the Congress. One of the features of the Congress was an exhibition of physiological apparatus gathered from various countries; many of the pieces so shown, including several valuable exhibits from this country, were presented by the makers or private individuals exhibiting them to the Observatory. These, under the care of Prof. Mosso, now belong to the physiological laboratory of the Regina Margherita Observatory.

Hence any physiologist who desires in the ensuing summer vacation to enjoy the united pleasures of high Alpine life and physiological investigation, and we trust that there are not a few such, can do so with ease or even in luxury, finding in the Observatory, not only quiet and shelter, but also almost every apparatus and appliance which he is likely to need. I think I may venture to say that my friend Prof. Mosso deserves the warm thanks, not only of all physiologists, but of all men of science, for what he has thus done. M. FOSTER.

PROF. EXNER ON SCIENCE AND THE STATE.

THE Vienna correspondent of the *Times*, writing on the 7th inst., comments upon a recent address of Prof. Exner which deals with the coming rule of technically trained men, that is, of men who can apply the principles of natural science; engineers trained in colleges as well as in works. The encouragement to scientific education given by foreign statesmen excites in this country only a feeble attention not unmixed with contempt. With us, higher education is still what it was in the time of Queen Elizabeth, and its advocates affirm that the education of men like Burleigh and Bacon, of Coke and Raleigh is good enough for statesmen of the twentieth century. This explains our difficulty in understanding Prof. Exner. Much of the pure science of the world is due to such British genius as could escape the academic net, and yet the power to apply that science is carefully kept away from the British people. We have started all the

branches of engineering; we have invented nearly all the important things, but the great development of these things has gone out of the hands of the amateurs of our nation. It is because our statesmen are Gallios who "care for none of these things," because they know nothing of science. Huxley failed to move them. The German Emperor's fosterage of engineering only amuses them, and hence our manufacturers blame everything except their own ignorance for their loss of trade. Prof. Exner wants to put the technically educated man in charge of all departments of Government which have to do with manufacture and distribution; with the use of all tools, including, we presume, guns and other weapons of destruction. He does not seem to know what is so obvious to us in England; that the Ministers in charge of departments must have had such a training of another kind that it is impossible for them also to be engineers. All we ask is that they shall know just a little about science, so that they may be able to take scientific advice. But alas! even this condition of things is remote. However important it would be to have men of the quality of engineers as their advisers or in charge of the various parts of a great department, there are qualifications more important—power to coax the Treasury for necessary money; social qualities such as come from good birth and enable one to keep one's superiors favourably disposed; qualities created by official life which enable one to work obediently as part of the official machine and never get into a rage; the knowledge that if ever there is a conflict between official law and a law of nature, it is the official law which must be obeyed. For our reform what is wanted is a cataclysm, rather destructive, but not too much so.

J. P.

NOTES.

We see with deep regret the announcement of the death of Prof. A. Cornu, whose numerous researches in physics are known throughout the scientific world. An account of the life and work of this distinguished investigator will appear in another issue of Nature.

By the death of Lord Kimberley, the office of Chancellor of the University of London becomes vacant. Of the names of those who have been mentioned as likely to fill it with advantage that of Lord Rayleigh is obviously the most appropriate. The new teaching University of London must achieve a high reputation on scientific lines or it will fail of its mission; a mere politician as a figure-head would be an anachronism.

Prof. Ray Lankester, in a letter to the *Times* of April 15, raises a new point in relation to the Rhodes scholars at Oxford. He states that the University of Oxford keeps its college residences, lecture rooms and laboratories open for only twenty-one weeks out of the fifty-two which make up a year; so that "it will not be worth while for a young German of ability to sacrifice three or four of the best years of his life to dawdle through the Oxford half-time system, even when paid 300*l.* a year for doing so." If it be true that the laboratories are shut for thirty-one weeks in the year, then certainly the sooner William Morris's idea of dispersing the inhabitants and consecrating Oxford to Death and Beauty, the better for others as well as the Germans to whom Prof. Lankester refers.

The high esteem in which the late Sir John Donnelly was held was shown by the large body of mourners that attended his funeral at Brompton Cemetery on Friday last besides the members of the family. The Lord President of the Committee of Council on Education was represented; and among other mourners were the Clerk to the Council, the vice-president and officers of the Board of Education, representatives of the Victoria and Albert Museum, Geological Survey and Museum of Practical Geology, Royal College of Science, and Solar Physics Observatory. The Royal Society, Royal Academy, and the London Technical Education Board were also represented. Among the wreaths was one bearing a card on which was printed: "A tribute of affectionate regard from the vice-president of the committee of council, officers and staff of the (late) Department of Science and Art, including the Victoria and Albert Museum, the Royal Colleges of Science and Art, and the Geological Survey and Museum, 11 April, 1902." Another wreath was from the Dublin Science and Art Institution: "In token of affectionate remembrance and sincere regret from those who served under Sir John Donnelly." Other wreaths were sent by Sir Trevor and Lady Lawrence, Sir Lawrence and Lady Alma-Tadema, and many others. The Victoria and Albert Museum was closed on the morning of the funeral.

Dr. J. Larmor, Sec. R.S., and Dr. Oliver Lodge, F.R.S., have been elected members of the Athenæum Club under the rule which empowers the annual election by the committee of nine persons "of distinguished eminence in science, literature, the arts, or for public services."

At the meeting of the American Philosophical Society held on April 4, the following were elected to membership:—*Residents of the United States*—Dr. J. A. Brashear, Dr. Andrew Carnegie, Prof. W. B. Clark, Prof. Hermann Collitz, Mr. G. K. Gilbert, President A. T. Hadley, Prof. G. E. Hale, Prof. P. Haupt, Prof. A. A. Michelson, Mr. C. Hart Merriam, Prof. T. W. Richards, Prof. F. E. Schelling, Prof. R. H. Thurston, Mr. B. C. Tilghman, Prof. R. S. Woodward. *Foreign Residents*—Prof. A. H. Becquerel, Prof. J. G. Darboux, Sir Michael Foster, K.C.B., F.R.S., Prof. G. Johnstone Stoney, F.R.S., Prof. S. P. Thompson, F.R.S.

As already announced, the German Association of Natural Philosophers and Physicians will hold its seventy-fourth annual congress at Carlsbad on September 21–28. As on former occasions, the rule that lectures and debates may be carried on in any language of the world will be followed, and foreign visitors will be accorded the same privileges as the ordinary members of the association enjoy. It is estimated that between 6000 and 8000 representatives of natural philosophy and medicine will gather at Carlsbad, and great preparations have already been made there to receive the members and friends of this famous association. Nearly all the principal professors of the Berlin, Vienna, Prague and most of the other continental universities and important colleges will be present, and twenty-eight different branches of ancient and modern science will form the programme for the lectures and debates. At the exhibition of scientific objects, which will be held in connection with the congress, no charge will be made to exhibitors for the space required, nor will any entrance fee be asked from visitors. Inquiries or letters should be addressed to "The 74th Congress of Natural Philosophers at Carlsbad."

In reply to a question relating to the North Sea Fisheries, Mr. Gerald Balfour stated in the House of Commons on Monday that the Government has agreed to take part in the international scheme of investigations connected with fishery problems in the North Sea and adjacent waters as proposed by the conferences held at Stockholm and Christiania, and Parliament will be asked to make a grant to defray the cost of the British share of these investigations. These funds will be administered by a departmental committee with the advice o scientific experts. The details of the investigations will no doubt be finally settled at the forthcoming meeting of the inter

national council at Copenhagen, at which Great Britain will be represented, but the date of which has not yet been fixed. The Board of Trade has also appointed a committee under a minute dated August 13, 1901, to inquire and report as to the best means by which the State or local authorities can assist scientific research as applied to problems affecting the fisheries of Great Britain and Ireland, and, in particular, whether the object in view would best be attained by the creation of one central body or department acting for England, Scotland and Ireland, or by means of separate departments or agencies in each of the three countries. Quite apart from this important question of scientific research, the Board of Trade has, with the assistance of another committee, considered how the present system of collecting fishery statistics in England and Wales could be improved and extended. The chief recommendations of this committee are referred to below.

THE *Times* has published the recommendations of the inter-departmental committee appointed "to inquire into the system of collecting fishery statistics in England and Wales, and to report how it could be improved and extended, and what additional cost (if any) would be entailed thereby, having special regard to the opinion expressed by the Select Committee of the House of Commons on Sea Fisheries, 1893, and the proposals of the Stockholm Conference, 1899." Among the suggestions are:—the extension and improvement of the present system of employing collectors at the fishing ports with the view of obtaining fuller details relating to fishery statistics; the preparation of separate returns as to the amount of fish caught in Icelandic and Faroese waters and in the Bay of Biscay and on such other new fishing grounds as it may from time to time be found desirable and practicable to distinguish; and that conger eels, dabs, gurnards, lemon soles, skate and rays, and whiting should be separately distinguished. The present report does not extend to statistics of salmon or fresh-water fish. The adoption of the recommendations would involve an annual expenditure on the collection of fishery statistics of 2135*l*., or 1435*l*. beyond what is provided at the present time, and a further annual expenditure of at least 1000*l*. for the supervision of collectors and for obtaining the additional information already described.

NEWS has come to hand that Dr. Elliot Smith, professor of Anatomy in the Medical School at Cairo, has been given two months' leave of absence to investigate at once some human remains discovered at Girga, in Upper Egypt. The graves containing the remains are said to consist of a continuous series extending over an interval of at least 8000 years, which represent the most archaic of prehistoric periods. The bodies are so well preserved, owing doubtless to the dryness of the atmosphere where they were interred and to the perfection of interment, that not only can the hair, nails and ligaments be made out, but the muscles and nerves. In almost every case the brain is said to be preserved, and the climax has been reached in two examples where the eyes with lens in good condition are present, and in others in which Dr. Elliot Smith has already observed the limb plexures and great splanchnic nerve. There are also now unearthed a series of later prehistoric graves, ranging throughout the first fifteen dynasties, others of the eighteenth, and yet others of the Ptolemaic and early and recent Coptic periods. This vast "cemetery" has been excavated by Dr. Reisner for the University of California, and we can but congratulate him and the Egyptian Government on having secured the services of so competent an anthropotomist as Dr. Elliot Smith, whose full report will be eagerly awaited.

A MEMORIAL to the late Dr. John Anderson, F.R.S., the first superintendent of the Indian Museum at Calcutta, has recently been erected in the upper eastern verandah of the main Chowringhi building. The memorial is in the form of a full-face medallion portrait in bronze, and is the work of the eminent Scottish academician, D. W. Stevenson. It is completed by a brass tablet, upon which the following words are inscribed:—"John Anderson, M.D., F.R.S., First Superintendent of the Indian Museum, 1865–1886. Besides organising and arranging the zoological and archæological sections of this Museum, he made large collections and many discoveries in Yunnan and Mergui, and achieved enduring distinction by his original contributions to vertebrate zoology. (Presented to the Museum by his widow and friends, 1901.)" Referring to the memorial, the *Englishman* remarks:—"As the gift of Dr. Anderson's friends, the location of the memorial is happily chosen; but from a wider point of view the museum itself—at least in its zoological and archæological sections—is *monumentum aere perennius* of Dr. Anderson's work in India, for although the institution has considerably developed since his time, it has done so strictly along the lines—well in advance of their day—that he laid down and fashioned. Dr. Anderson will also be remembered as one of the earliest advocates of a zoological garden for Calcutta, and as having greatly helped to shape the institution also when it was started." Every naturalist will be glad to know that Dr. Anderson's valuable work has been commemorated in this way. His labours could not easily be forgotten even if no memorial had been erected, but students unfamiliar with his career should be reminded of the great work he accomplished. In connection with this subject it is worth mention that the volume on "The Mammals of Egypt," on which Dr. Anderson was busily engaged when a brief illness unexpectedly terminated his useful life, will be published during the present year. This will be the second volume of Dr. Anderson's important work on the zoology of Egypt, and it will be similar in every respect to the first volume, on the reptiles of Egypt.

IN a discussion on West Africa at the monthly dinner of the London Chamber of Commerce on April 9, Sir Harry Johnston remarked that we were much behind Germany and France in respect of the scientific examination of the territories under our control. Writing to the *Times* upon the subject, he defends the Foreign and Colonial Offices from charges of want of sympathy with purely scientific work (examination of rainfall, fauna, flora, geology, minerals, &c.) in our African possessions by pointing out that they were often prevented from carrying out such work by the reluctance of the Treasury to expend national moneys in that direction. Referring to the Uganda Railway he says, "if in past decades we had been allowed to spend, say, 20,000*l*. in the scientific examination of East Africa, the knowledge thus acquired might have enabled us from omniscience to make the Uganda Railway for some half a million less money. Lacking this prior knowledge, those engaged in the construction of this remarkable line have done their very best to avoid mistakes and unnecessary expenditure, and the result is wholly creditable to the Office which employed them. The Treasury is sometimes unsympathetic towards scientific research, but the Treasury, after all, is only an exponent of the national will. It is the nation—the Empire—at large which is so indifferent to the value of scientific research, more especially in the domains of anthropology, zoology, botany, geology, and meteorology, that it cares little for the scientific examination of its territories, new and old. Some of this work can be done by private enterprise and generosity. But much might be accomplished by the Government if the Treasury would but agree. I am not asking for an expenditure of a million sterling per annum, or of even one of those unconsidered hundred thousand pounds cheerfully spent without blinking on an armed and punitive expedition. Twenty thousand pounds wisely expended on three scientific expeditions in West Africa, East Africa, and British Central Africa would probably give us all the information we require as to the products, soils,

minerals, natural history and human races of our tropical African dominions.

A NUMBER of prizes, varying in value from 800 to 8000 francs, are offered by the Belgian Royal Academy of Medicine for researches in various branches of pathological and medical science. The largest prize is offered for discoveries relating to the diseases of the nervous centres, with special reference to epilepsy, and for a really valuable discovery, such as a curative remedy for epilepsy; two premiums, one being of 5000 francs, may be given in addition to the prize of 8000 francs.

WE have received from Mr. J. Baxendell the report of the Fernley Observatory, Southport, for the year 1901. Mr. Baxendell continues his useful experiments and comparisons with the view of improving the records of self-recording instruments, especially those obtained from anemometers of various patterns. We quote the following climatological data from this important observatory:—Extremes of shade temperature, 88°·4 in July, 19°·1 in January and December; highest solar temperature, 129°·1, in August. Total rainfall, 26·7 inches, nearly 7·5 inches below the average. Bright sunshine (Campbell-Stokes recorder), 1738 hours. The report contains an interesting comparison of climatological statistics with upwards of fifty other health resorts.

MR. W. E. COOKE, Government Astronomer of Western Australia, has published a paper on the climate of that colony, from observations made during the years 1876–1899, containing a large number of valuable tables showing the monthly means and extremes of the various elements, illustrated by maps. The latter show that the records refer mostly to stations on or near the coast, and that the inland districts are, to a great extent, still unrepresented. In addition to the climatological tables, general descriptions of the types of weather most frequently experienced, and of the climate, with especial reference to that of Perth, are given in the text, and will be found very useful to all interested in the meteorological features of the country. Taking Perth to represent the south-west and south coastal stations, the mean monthly temperature is 64°·9, the highest extreme being 116°·7 and the lowest 31°·2. The mean annual rainfall is 32·9 inches. Within the tropics, records of 110° are not infrequent, the absolute maximum being 123°, at Onslow, in February, 1897. Thunderstorms, accompanied by heavy rain, are frequently experienced; the heaviest fall ever recorded was 36·49 inches, near Cossack, on April 2–3, 1898. On the other hand, only 0·73 inch was recorded in this district during twenty months ending January, 1892.

A NEW application of the electric furnace which may prove to be of great practical importance was described by Mr. C. B. Jacobs in a paper read before the New York section of the Society of Chemical Industry. The raw material for most of the barium compounds in common use is barytes, the natural sulphate, and this is usually converted into other barium compounds by treating it with coal or coke in a reverberatory furnace and then working up the crude barium sulphide thus obtained. It has been found that when barium sulphate and sulphide are heated together in suitable proportions at the temperature of the electric furnace, the sulphur is completely eliminated as sulphur dioxide and barium oxide remains, the conversion being so complete that only 2 to 3 per cent. of barytes remains unacted upon, as against 25 to 45 per cent. by the older process. By lixiviating with water and crystallising out, barium hydrate is obtained at once, containing only about 1 per cent. of impurities, chiefly barium sulphydrate. From this all the other barium salts are readily obtained. The electrical energy required for this process is got from the Niagara Falls, and the plant in use at the present time is turning out sixty tons per day. The fields into which it is finding its way are the tanning industry, the white pigment and dry colour trades, the purification of water for industrial purposes, and general manufacturing chemistry. The largest consumption, however, is in the beet sugar industry, for the recovery of the sugar remaining uncrystallised in the molasses. Barium hydrate is an ideal substance for the softening of water for boiler purposes, and its general introduction in place of the methods at present in use is only a question of price.

THE structure and design of electric automobiles are at present attracting much attention from electrical engineers. Sir H. P. Maxim in a lecture recently delivered before the Automobile Club of New York, commented on the progress made in the design of accumulators. The capacity of the cells per kg. of battery weight has been doubled, while the life of the plates has been increased 25 per cent. by the improvements made within the last three years. The best type of accumulator cell can now be utilised for running 8000 kms. before renewal of the plates is necessary. The electric automobile, in Maxim's opinion, is superior to all other types of automobile for general use. It is only likely to be supplanted by the petroleum or light spirit type of vehicle, where economy is the chief consideration, or where the distances to be covered are beyond the range of the electrically propelled car. Many of the latest types of electric automobile possess motors designed to act as dynamos for recharging the battery when the car is running downhill. A German engineer, Th. Müller, of Nuremberg, has been investigating the reality of the advantages claimed for this type of vehicle, and the details of his inquiry will be found in the *Zeits. f. Accumulatoren und Elementen-kunde* for March 1, 1902. The increased amount of copper required for motors, intended to act under such conditions as dynamos, and the greater complexity of their design, are held by Müller to quite counterbalance the gain of 10 to 15 per cent. which is all that results in the distance capacity of the cars.

A STATISTICAL comparison of developments of German and British trade in recent years is made in a long article in the *Times* of April 3. Though the writer seeks to show that there is little cause for uneasiness, he admits that Germany has advanced more rapidly than Great Britain in many departments of industry and commence. Especially is this true as regards chemical goods and electrical machinery, but no particulars as to these advances are given. So many industries depend upon chemical science for their means of progress that the present advantage which Germany possesses in applied chemistry is likely to produce far-reaching effects. Upon this subject the writer remarks:—"Years of research and theoretical training had made the German chemist *facile princeps*. Even in Great Britain, in France and in the States most leaders of the chemical trades and most assistants are Germans by birth or training; of Germany the chemical trades are a speciality. The technical colleges had likewise bred a highly efficient army of electrical, metallurgical and mining engineers who would soon find ample scope for their talents. In addition, the German mind has always been scholarly by inclination and open by habit. The self-sufficiency and the indifference to foreign doings, so characteristic of the British trader, never have been features of the German. On the contrary, he has always been open to foreign influences, and eager to adopt foreign ways." In the metallurgical trades, also, it is stated that Great Britain has not kept abreast of the times. During the last ten years of last century our iron production only rose from 7,900,000 to 9,421,000 tons, or, say, 17½ per cent., whereas that of Germany went in the same interval from 4,658,000 to 8,143,000 tons, and, therefore, increased more than 75 per cent. If the rate of progress be maintained on both sides, the German iron production

will be greater than the British in about three years' time. The general conclusion reached is that though as a nation Great Britain has continued to advance, Germany has made more rapid progress.

THE observatory on the summit of Mont Blanc, such a familiar object to all who visit Chamonix, has furnished M. Jean Binot with the means for making bacteriological investigations at the highest altitude yet explored. His researches are published in the *Comptes rendus* of the Paris Academy of Sciences. As was to be anticipated, the air on the summit away from the observatory contains scarcely any bacteria whatever, only from 4 to 11 being detected in as much as a thousand litres, whilst in somewhat smaller volumes of air frequently none at all were discoverable. As a rule, at lower altitudes, the number of bacteria present increased; thus at the Plan de l'Aiguille 14, whilst at the Montanvert 49, were found in a thousand litres. Inside the observatory, in which M. Binot tells us he spent five days, from 260 to 540 microbes were found in the same volume of air; these bacteria were doubtless introduced during the temporary invasion of the building by M. Binot and his companions. The investigations were not, however, confined to the air on the top of the mountain, but included also bacterial examinations of freshly fallen snow, old snow, ice on the surface and below, glacier water, and mountain streams. Freshly fallen snow, even when sampled in large quantities, frequently contained no bacteria whatever, whilst in snow which had lain for some time usually only from one to two individuals were discoverable per cubic centimetre; at the foot of the glaciers the surface snow contained rather more, the number varying from 6 to 65 per c.c. at the Mer de Glace. Glacier water is usually very pure, and, like the glacier-ice from which it is derived, was found to contain a number of yeasts and some streptothrix; but whilst high up such water contained but from 3 to 8 bacteria per c.c., a stream at the foot of the Glacier des Bossons contained 95, whilst the water of the river Arve at Chamonix was found to have as many as 7550 per c.c. Altogether M. Binot examined 121 samples of air, ice, snow and water, and isolated no less than 300 different varieties of microbes, one-third of which number he was able to identify as having been already studied and described, and the residue are being carefully investigated by him at the present time. Of great interest is the author's remarkable discovery of a virulent race of pyocyaneus bacilli in ice on the top of Mont Blanc; he also isolated from water a vibrio highly pathogenic to animals. Even the alluring and beautifully clear and crystalline spring water on the Montanvert road was condemned by being found to contain a dozen virulent colon bacilli in a cubic centimetre. Doubtless this pollution was due to the herds of cattle which graze on the mountain pastures.

IN the *Biologisches Centralblatt* for April, Dr. A. Bethe makes a further contribution to the discussion as to the nature of the "homing" instinct of bees and ants.

PART vi. of the second volume of the *Annals* of the South African Museum is devoted to a revision of the species of certain groups of the scorpions of the country, in the course of which several new forms are described.

IN the April number of *The Entomologist*, Miss Sharpe completes her list of the butterflies and moths collected by Dr. Christy in Nigeria. It is remarkable that a species hitherto believed peculiar to Aden should recur in West Africa.

THE annual report of the Indian Museum, Calcutta, for 1900-1901, states that important progress has been made in the improvement of the exhibited series, in the cataloguing of the reserve collections, and in the exchange and distribution of duplicate specimens. The acquisitions have been numerous, and, for the first time, the exhibited specimens have been adequately labelled in large type. The plan of replacing stuffed and spirit specimens of snakes by coloured casts is being carried out as rapidly as possible. A gallery has been reserved for economic zoology. Mr. T. H. Holland, of the Indian Geological Survey, has joined the board of trustees, in place of Mr. R. D. Oldham, retired.

THAT acquired characters may be inherited is suggested by Dr. Kidd's investigations into the arrangement of the hair on the human forehead, of which an account is given in the April issue of the *Journal of Anatomy and Physiology*. Certain lines of divisions appear in most cases, which are regarded as derived from the style of "parting" adopted by the parents. In the same publication, Mr. W. L. H. Duckworth, from the study of certain peculiarities in the skulls of a gibbon and an aboriginal Australian, is led to believe that in certain respects the man-like apes have attained a higher platform of specialisation than man himself.

IN the *Entomologist's Monthly Magazine* for April, Mr. C. W. Dale gives an account of the occurrence of the "mazarine blue" butterfly (*Lycaena acis*, or *Nomiades semiargus*) in Britain. According to the author, no specimens have been taken in our islands for more than twenty years; it is suggested that its extermination there may have been due to the attacks of hymenopterous parasites, although there is no evidence that this was the case. Never abundant, the species has been recorded from twenty-one English and Welsh counties, in several cases only on the evidence of a single specimen.

A MEMOIR in the *Quarterly Journal of Microscopical Science* describes the results of an investigation into the morphology of the skull of the bony fishes, based on an examination of its development in the three-spined stickleback. In addition to noting many points connected with the details of skull-structure, the author, Mr. H. H. Swinnerton, finds that his study of the anatomy and developmental history of the head-skeleton shows that the sharks and rays on the one hand, and the bony fishes and ganoids on the other, appear to have had a common ancestor, whose chief structural features are briefly indicated. It is added that the term "hyostylic," commonly used to indicate the mode of suspension of the lower jaw to the cranium in the latter group, does not adequately express the true state of the case. In another paper in the same journal dealing with what are commonly called "fishes," Dr. E. Warren discusses the structure of the teeth of the lampreys and hag-fishes. He remarks at the outset that those who regard these creatures as degenerate descendants of ordinary fishes would expect to find in their horny teeth remnants of the calcified structure of those of other vertebrates. He finds, however, no definite evidence of such degeneration, but adds that if they are actually degenerate they have reverted to a condition which probably preceded the development of the "placoid" scales of the sharks and rays.

AN interesting article in the March number of the *American Naturalist*, by Dr. H. P. Torrey, describes a peculiar phenomenon seen on the Californian coast during the past summer. Early in July a red streak was noticeable in the sea off San Pedro Harbour, which during the next few days approached the shore and divided into several patches of many acres in extent. On the 16th these patches reached the shore, where they were the cause of a most unusual display of phosphorescence. The discoloration and phosphorescence of the water were due to the presence of swarms of flagellate animalcules. "On the 20th, four days after the red (characteristically a muddy vermilion) streak had reached the shore, a most sickening odour arose from the water along the beach. During the night, on a beach about 400 feet long, a large number of animals were lef

by the tide. Among them were several hundred holothurians, several specimens of two species of sting-ray, two species of guitar-fishes (Rhinobatus), two cestracionts, two dog-fishes, a red perch, a large number of smelts, and several octopi." The "red water" occurred for at least two hundred miles along the coast and extended several miles out to sea; it had not disappeared at the beginning of September. Wherever it occurred food-fishes were scarce; but the small harbour-fishes and invertebrates of the "plankton" were unaffected. Towards the end of July, the animalcule Noctiluca appeared in swarms and devoured the animalcules of the red water. A somewhat similar visitation is reported to have occurred five hundred miles further south in the seventies, but has never before been known in California.

AN interesting case of peloria was furnished by a Cattleya which Dr. Masters showed at a recent meeting of the scientific committee of the Royal Horticultural Society. This abnormal flower appeared on a plant produced by crossing *Cattleya Schröderae* with *Brassavola Digbyana*. It showed three regular sepals, and alternating with these three petals, alike in size, colour and shape. The column was normal.

A RECENT number of *Science* records the proceedings of a number of prominent American botanists, now organised under the name of "The Botanists of the Central States." The meetings were held at the University of Chicago, under the chairmanship of Prof. J. M. Coulter. Among the papers read were the following:—F. C. Newcombe, "The sensory area of the roots of land plants"; H. L. Lyon, "The phylogeny of the cotyledon"; C. A. King, "Fertilisation and some accompanying phenomena in *Araiospora pulchra*"; H. S. Reed, "The ecology of a glacial lake"; R. A. Harper, "Binucleate cells in certain Hymenomycetes."

A CATALOGUE of plants has been received from Mr. H. P. Kelsey, the proprietor of the Highlands Nursery, N. Carolina, U.S. Mr. Kelsey has successfully undertaken to bring before Americans the wealth and richness of their native flora. The nurseries are situated at a height of 4000 feet, and naturally lend themselves to the production of such alpine or subalpine genera as Rhododendron, Kalmia, Tsuga, Leucothœ and Andromeda. To the cosmopolitan grower of interesting or little-known plants, this list of hardy American specialities will suggest many future possibilities.

VARIOUS explanations have been put forward to account for the production of cleistogamic flowers. No simple explanation has been offered which would cover the phenomenon in all cases; indeed, it is much more probable that they are formed in response to different stimuli, or for different purposes. In the second volume of the *Publications of the University of Pennsylvania*, Dr. C. H. Shaw discusses the formation of cleistogamic flowers in two American species of Polygala. One of these, *Polygala polygama*, produces both aërial and subterranean forms. The latter occur in early summer at the same time as the normal flowers, while the former are found later, on shoots which may have borne open flowers and which at this time develop a geotropic tendency. The morphological differentiation of the aërial cleistogamic flowers is intermediate between that of the other two varieties. The formation of the cleistogamic flowers seems to be correlated with the economic and rapid production of seed, for the normal flowers fail to a great extent to set seed, and require a longer time to mature it.

FROM two leaflets which we have received we notice that Kodak, Ltd., have two novelties which they have recently brought out. One of these consists of a kodak made especially for the use of glass plates alone, and fitted with the usual neat and simple movements and adjustments, many of which can be operated with one hand. These cameras are made in two sizes, for quarter and 5×4 plates, and both are fitted with Bausch and Lomb's lenses and shutters. The other new announcement is the number two stereo kodak for taking stereoscopic or single pictures $3\frac{1}{2} \times 3\frac{1}{2}$ in. on cartridge film. The camera is of the box pattern, measuring $8 \times 4\frac{3}{4} \times 6$ in., and requires no unfolding when a photograph is about to be taken. The shutters are ever-set, and are simultaneously operated for time or instantaneous exposures by separate levers. A third lever actuates three stops, and its position indicates which stop is in front of the lens.

THE additions to the Zoological Society's Gardens during the past week include a Caracal (*Felis caracal*) from South Africa, presented by Mr. F. C. Longbourne; a Suricate (*Suricata tetradactyla*) from South Africa, presented by Miss Philippe Stephenson; three Common Vipers (*Vipera berus*), British, presented by Mr. A. Old; a Diana Monkey (*Cercopithecus diana*) from West Africa, deposited; two Alpine Choughs (*Pyrrhocorax alpinus*), European, purchased; six Shaw's Gerbilles (*Gerbillus shawi*), three Black Swans (*Cygnus atratus*), bred in the Gardens.

OUR ASTRONOMICAL COLUMN.

TOTAL ECLIPSE OF THE MOON (April 22).—There will be a total eclipse of the moon on the evening of Tuesday, April 22, which will be partly visible in England. The total phase will be reached before moonrise at Greenwich (7h. 5m.), so that only the latter part of the phenomenon can be observed. The following particulars are for Greenwich mean time:—

	h.	m.
First contact with penumbra	3	50·3
,, ,, shadow	5	0·2
Beginning of total phase	6	10·2
Middle of eclipse	6	52·8
End of total phase	7	35·4
Last contact with shadow	8	45·4
,, ,, penumbra	9	55·3

The first contact with the shadow occurs at 89° from the north point of the moon's limb towards the east; the last contact at 60° towards the west.

Magnitude of eclipse (moon's diameter = 1) = 1·337.

In consequence of the eclipse taking place near the time of moonrise, it will be interesting, wherever the surroundings permit, to observe the setting sun and eclipsed moon simultaneously at opposite points of the horizon.

NEW VARIABLE STARS.—4 (1902) *Geminorum.*—Prof. Ceraski announces the variability of the star BD + 20°·1875, determined from photographs taken at Moscow. Its position is

$$\left.\begin{array}{l}\text{R.A.} = 7\text{h. } 32\text{m. } 37\text{s.}\cdot0 \\ \text{Decl.} = +\,20^\circ\ 45'\cdot3\end{array}\right\}(1855).$$

The magnitude is usually stated to be 9·0, and at present the brightness is increasing.

5 (1902) *Lyrae.*—In the *Astronomische Nachrichten* (Bd. 158, No. 3783), Mr. A. Stanley Williams announces the discovery of a new variable in Lyra whose coordinates are

$$\left.\begin{array}{l}\text{R.A.} = 18\text{h. } 56\text{m. } 12\text{s.} \\ \text{Decl.} = +\,37^\circ\ 18'\cdot7\end{array}\right\}(1855).$$

All the observations up to the present time are photographic, from plates taken with a 4·4-inch portrait lens.

The magnitude appears to vary between 10·6 and 12·0. From the dates of the minima it would seem to have a period of about two-thirds of a year, and in this case the next maximum should occur in or about the month of July 1902.

THE PHOTOGRAPHY OF DISTURBANCES IN AIR.

IN a paper read before the Royal Philosophical Society of Glasgow on December 4, 1901, and published in the *Proceedings* of the Society, Mr. H. S. Allen, of the Blythswood Laboratory, gives an account of "The Photography of Sound Waves and other Disturbances in Air." The method of striæ (Schlieren Methode) was devised by Toepler more than thirty years ago. This method makes it possible by suitable optical arrangements to render visible disturbances in which the refractive index differs but little from that of air.

One form of these arrangements is shown in the diagram, Fig. 1. The light proceeds from a source L which is as nearly as possible a straight line. In the figure this line of light is seen only in section—it is supposed to be at right angles to the plane of the paper. The light issuing from this source falls on a large concave mirror, M, by which it is brought to a focus just in front of the lens of the camera at I. One half of the lens is covered with an opaque screen, having a straight edge parallel to the image of the source, and the apparatus is arranged so that the image falls exactly on this straight edge Then, if all the adjustments are ideally perfect, no light at all will enter the camera so long as the medium through which the light passes is homogeneous. But supposing there is a region in the path of the light having a density different from that of the surrounding atmosphere, some of the light may be bent aside so as to enter the lens of the camera. Such a region is represented in section by the circle in the figure. It is supposed to be of greater density than the air around. The paths of the rays which have been refracted in passing through it are represented by the dotted lines. It will be seen that light traversing the lower portion is bent upwards and enters the camera, while light passing through the upper portion is bent downwards and falls still further than before from the boundary of the opaque screen. If the camera is focussed on this region of greater density, the lower part (that

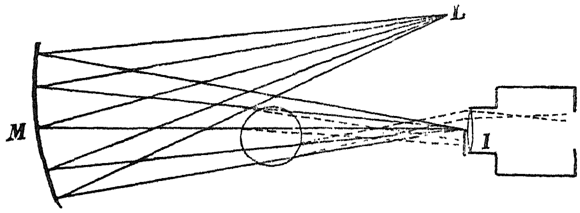


FIG 1.

is the upper in the camera, the image being reversed) will be illuminated, while the upper portion remains dark.

In working the method, the source of light and its image on the diaphragm must necessarily be of finite width, and the adjustments are made so that a certain fraction of the width of the image falls on the screen while the light from the remaining portion passes through the lens and gives rise to a uniform field. In these circumstances, the upper part of the region of greater density would appear dark against a light field. The sensitiveness of the method depends on the relative proportion of the light stopped by the screen and the light that enters the lens. For photographic purposes there must be a moderate amount of light to produce any effect even with the most sensitive plates, so that eye observations are considerably more sensitive. When it is desired to view the disturbances directly the camera is replaced by a telescope, or the image formed by the camera lens is examined by a suitable eyepiece.[1]

The mirror used was originally designed for a reflecting telescope. Its diameter was 18 inches, and it had a radius of curvature of 30 feet 3 inches.

One of the most striking applications of the method is the photography of sound waves—waves of compression set up by sudden electric discharges. Prof. R. W. Wood has taken a large number of photographs showing the behaviour of these waves (*Phil. Mag.* xlviii. p. 218, l. p. 148).

The arrangement of the apparatus is shown in Fig. 2. At the lower part of the diagram are the terminals, which supply an electric current at a high potential. The source of the current

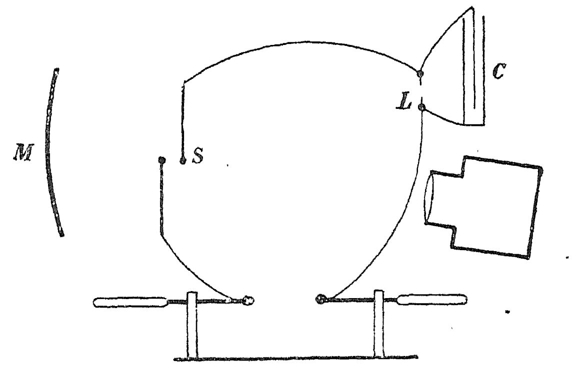


FIG. 2.

may be either an induction coil or an influence machine. From one terminal a wire is led to the spark gap placed in the path of the light travelling from the mirror to the camera. It is this spark which gives rise to the wave of compression to be observed, for convenience it may be termed the sound spark. The terminals are brass balls $\frac{3}{8}$ inch in diameter, and they are placed one behind the other, so that the light from the spark may not enter the camera. From this spark gap a wire is led to a second, which serves as the source of illumination, and is therefore provided with magnesium terminals. The circuit is completed by a wire from this point to the second terminal of the electrical machine. It is necessary that the light spark should take place somewhat later than the sound spark, in order to give the sound wave time to travel a sufficient distance from the terminals to be observed. To effect this a condenser is placed in parallel with the light spark, so that the light spark is delayed by the time necessary to raise the potential of the condenser high enough to spark across the gap.

A number of photographs were taken illustrating the reflection of a sound wave at surfaces of various forms and the effect of a diffraction grating. The original negatives were $\frac{7}{8}$ inch in diameter. They were enlarged to about three times this diameter for use as lantern slides.

The compression in one of these waves must be considerable compared with that due to an ordinary musical note. We may, perhaps, form a rough estimate of the amount of compression from the fact that the wave-fronts are seen at least as clearly as

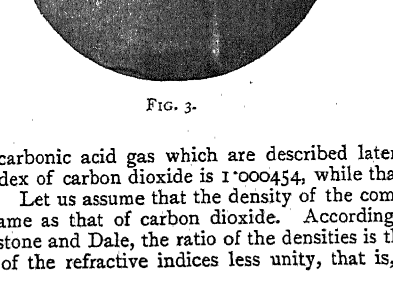


FIG. 3.

the jets of carbonic acid gas which are described later. The refractive index of carbon dioxide is 1·000454, while that of air is 1·000294. Let us assume that the density of the compressed air is the same as that of carbon dioxide. According to the law of Gladstone and Dale, the ratio of the densities is the same as the ratio of the refractive indices less unity, that is, in this

[1] A somewhat curious effect is observed with the optical arrangements just described which might form the basis of an optical illusion. If the eye is placed close behind the back of the camera (the ground glass screen being removed), the source of light with the apparatus for producing the light is distinctly seen, but when an eyepiece focussed on the back of the camera is employed, the apparatus for producing the disturbances in the air is seen with the mirror as a background. In the former case, the eye sees the real image of the source just in front of the lens and so close to it as to be practically unaffected by it, while the image which can be seen with the aid of the eyepiece is so near the eye as to be invisible.

case the ratio of 454 to 294, or, roughly, of 3 to 2. Thus, with these assumptions, the density in the wave-front is half as great again as the density of the undisturbed air. The wave resembles that caused by an explosion rather than that due to an ordinary sound.

Several attempts were made to see the train of waves due to a musical note, but on consideration of the facts just stated it is not surprising that they were all unsuccessful. The notes due to a shrill whistle and to a siren blown by a pair of foot bellows were both ineffective.

An attempt was also made to obtain a train of waves from the oscillatory discharge of a condenser through a circuit possessing

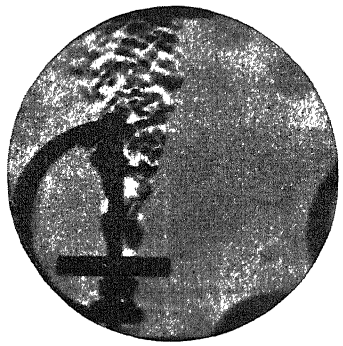


FIG. 4.

self-induction. A large Leyden jar and a coil of wire were inserted between the main terminals in Fig. 2. The frequency of the oscillation lay between the limits 7920 and 1800 vibrations per second, the wave-length of the corresponding sound-wave lying between 1·3 and 7·3 inches.

A number of photographs were obtained in which the first wave-front had travelled to such a distance that the second wave should have been clear of the terminals. But in none of them is any trace to be seen of a second wave. Thus, as an attempt to photograph a train of waves, this method too proved a failure.

Even as a failure the result is not without its interest, as it brings out very clearly the difference in character between the first discharge and the surgings that follow it when the spark is an oscillatory one.

In the words of Prof. Trowbridge, who has made a special study of oscillatory discharges:—"Photographs of powerful

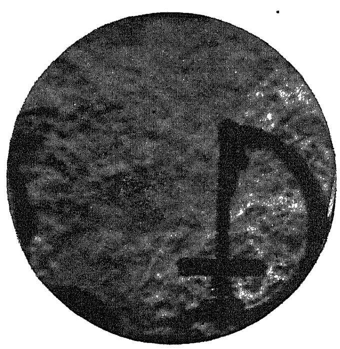


FIG. 5.

electric sparks lead one to conclude that a discharge of lightning makes way for its oscillations by first breaking down the resistance of the air by a disruptive pilot spark—through the hole thus made in the air the subsequent surgings or oscillations take place."

In the language of the modern ionic theory this would be interpreted by saying that the first disruptive discharge results in the production of a large number of free ions, and these ions offer an easy passage to the subsequent oscillations.

Since the refractive power of a gas is proportional to its density, and that in turn depends on the temperature, the method will reveal the presence of any region in the air whose temperature differs materially from that of the surrounding atmosphere. Such a case arises in every flame; the products of combustion rise from the flame as a column of heated gas, and this is revealed to the eye as a pillar of fire, or in the photograph as a pillar of cloud. The photograph shows the effect due to the flame of a spirit lamp (Fig. 3).

In order to impress the fact that what is here seen is not the flame, but the heated gas rising from the flame, a small fan was arranged which could be set in rapid rotation and so drive the hot gas all over the field of view (Fig. 4). The photograph (Fig. 5) shows the effect when it has been set rotating.

The flame of a Bunsen burner gives rise to a disturbance similar to that due to the spirit lamp, but more voluminous in character. The peculiar spiral form in which the column of gas rises before breaking up into a cloud is very noticeable in some of these photographs of flames.

A number of photographs were taken of jets of gas issuing from a narrow orifice. In one case the jet is formed by blowing heated air through a brass tube; in another it consists of carbonic acid gas issuing from the generating flask. In consequence of its great density, the gas begins to fall downwards soon after leaving the nozzle.

Several photographs were taken to show the mode of formation of a vortex ring of heated air. These rings were produced in the usual way by means of a box with an aperture in one side, and the opposite side formed of some elastic material. On giving this side a sharp tap, some of the enclosed air rushes out with the formation of a ring. In this case the air in the box was heated by placing a spirit lamp inside it so that the rings,

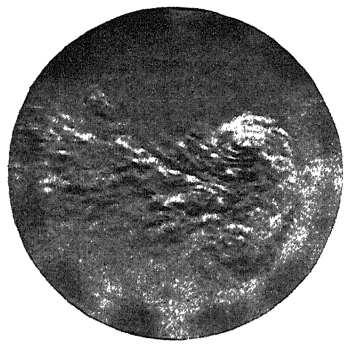


FIG. 6.

being formed of hot air instead of smoke, were quite invisible save by the use of the method of striæ. Some of these photographs are reproduced in the paper and are very instructive as showing the way in which the vortex motion is produced. The air appears first of all to issue from the orifice in the form of a column, but the tail is gradually left behind while the whirlpool motion of the head is accentuated. Finally, little is to be seen but the section of the ring itself, the spiral structure being strongly marked (Fig. 6). In some cases a circular, in others an elliptic orifice was used.

The appearance of some of these photographs showing vortex motion strongly recalls the published photographs of the nebulæ of the heavens.

THE TEMPERATURE OF INVERSION OF THE JOULE-KELVIN EFFECT FOR HYDROGEN.[1]

IN the year 1854 it was proved by Joule and Lord Kelvin that hydrogen on free expansion behaved differently to all other gases. Air, when allowed to expand from a higher to a lower pressure without performing external work, became cooled, the fall of temperature being proportional to the difference of pressure; hydrogen, on the other hand, became warmer. As is well known, the Joule-Kelvin effect has been applied by Hampson and Linde to the liquefaction of air in quantity, but since for hydrogen the effect is of opposite sign, it was obvious that the Hampson-Linde apparatus could not be directly applied

[1] By K. Olszewski. Translated from the *Bulletin* de l'Académie des Sciences de Cracovie. (December, 1901.)

to the liquefaction of that gas; a conclusion which is confirmed by this research. There seemed no doubt,[1] however, that after due modification the Hampson-Linde method would be applicable to the liquefaction of hydrogen, the necessary condition being that the gas should be cooled to below the temperature at which the Joule-Kelvin effect changes sign before entering the regenerator coil of the apparatus. Below this temperature the gas would become cooled on free expansion; as in the case of air in the ordinary Hampson apparatus, the cooling would be progressive and, were the heat insulation sufficiently perfect, would result in the partial liquefaction of the gas.

As is well known, Dewar and Travers (*Phil. Mag.*, 1901) have both succeeded in applying this principle to the production of liquid hydrogen. Both investigators employed as a preliminary refrigerant liquid air boiling under reduced pressure, and by this means cooled the hydrogen to $-200°$ C. The question now arises as to whether this is really necessary, or whether it would not be possible to liquefy hydrogen by allowing it to undergo free expansion after cooling it to a temperature less difficult to attain. The following investigation was undertaken in the hope of throwing some light on the subject and of determining the temperature at which the sign of the Joule-Kelvin effect changes.

Witkowski (*Roz. pr. Akad. krak.*, W.M.P. xxxv. 247; *id.* 1898) has applied two methods to the calculation of this temperature. The first method, based on the theory of corresponding states, gave $-46°$ C. as the temperature; the second method, in which Rose-Innes' formula was applied to the extrapolation of Joule and Lord Kelvin's experimental values at temperatures between 0° and 100° C., gave $-79°\cdot3$, a result which is nearer to that obtained by me experimentally, viz. $-80°\cdot5$. Rose-Innes' formula (*Phil. Mag.* [5], xlv, 228),

$$e = \frac{\alpha}{T} - \beta,$$

is purely empirical, but employing 64·1 and 0·331 as values for the constants, it reproduces the experimental results with remarkable accuracy.

Description of the Apparatus.

The hydrogen employed in these researches was obtained by the action of pure dilute sulphuric acid on commercial zinc; the gas was purified by passage through solutions of caustic soda and potassium permanganate, and finally through a tower containing pumice-stone soaked in mercuric chloride solution. The gas was collected in a zinc gasometer capable of holding 1200 litres, and from this was taken directly into the Whitehead torpedo-compressor, and compressed at 180 atmospheres into a steel cylinder of 13 litres capacity; in this cylinder was suspended a wire net containing sticks of caustic potash. During these operations every care was taken to remove all traces of air from the apparatus.

The expansion apparatus is shown in the accompanying figure. The steel cylinder, which contains the hydrogen under pressure, communicates by means of a copper tube with a manometer and with the tube *a* of the apparatus. The tube *a* is bent into a spiral *b*, which terminates in a valve *c*. The valve consists of a jet enclosed within a steel tube, perforated at the sides for the escape of the gas, which serves as a support for it. The valve spindle *d* passes through a gland packed with asbestos at *o*, and is screwed below *o* to fit the opening through which it passes, so as to allow of the valve being opened or closed. The valve is enclosed in a thin metal box *hh*, which is lined with chamois leather; the gas can escape by a tube *pi*, through the vertical portion of which an electric resistance thermometer is introduced. This instrument has previously been employed in the determination of the critical and boiling points of hydrogen (*Phil. Mag.* [5], xxxix. 199; xl. 202); the electrical connections are made by means of binding screws at *f* and *g*.

So as to be able to surround the coil *b* and the metal box enclosing the jet and thermometer with different refrigerants, the metal cap *nn* is cemented to the top of a thick-walled glass vessel *ll*. This in turn contains a thin glass vessel *mm*, insulated from the former at the top and bottom.

The refrigerating substances, liquid air, liquid ethylene, and solid carbonic acid and ether, can be introduced into *mm* through a T-tube passing through the cover of the apparatus, and by connecting one branch *k* with an exhaust pump the substance can be evaporated under reduced pressure and the temperature varied considerably. The temperature of the coil and jet can be roughly determined from the readings of a mercury manometer attached to the apparatus.

Method of Experiment.

The first experiments were made at about $-190°$ C., the temperature of liquid air. The initial pressure on the hydrogen was about 170 atmospheres, and on opening the valve for about five seconds a considerable cooling took place, the beam of the galvanometer attached to the electric thermometer moving 200 mm. over the scale. Using as a refrigerant liquid ethylene boiling at $-103°$ C., and with an initial pressure on the hydrogen of 150 atmospheres, cooling took place when the valve was opened, but to a less extent, the ray from the galvanometer moving only 30 mm. This was taken to indicate that the temperature of inversion lay considerably above $-100°$ C., and a series of experiments was next made about the temperature of solid carbonic acid and ether.

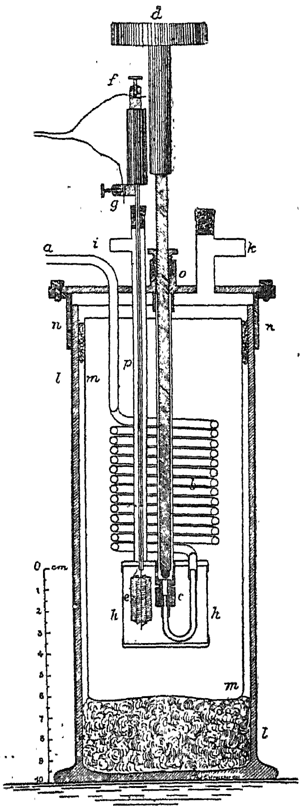


FIG. 1.

In this series twenty-five experiments were made, starting in each case with a temperature of $-78°$ C. and an initial pressure of between 117 and 110 atmospheres. To regulate the expansion, a small steel cylinder of 0·6 litre capacity was introduced between the main cylinder and the tube *a*; by filling the small cylinder from the main cylinder and closing the communication between the two before each expansion, the quantity of gas which escaped from the valve, and consequently the temperature change, was always the same. It appeared from these experiments that at $-78°$ hydrogen becomes warmer on free expansion, but only very slightly so, the ray from the galvanometer moving 3 mm. over the scale.

By reducing the pressure on the carbonic acid by careful pumping, the temperature was slowly reduced. At $-83°$, decided cooling took place on expansion, the galvanometer beam moving 5 mm. over the scale. By numerous trials it was found that the temperature at which the Joule-Kelvin effect became zero appeared to be at about $-80°\cdot5$ C.

Conclusions.

From these experiments it appears that the temperature of the inversion of the Joule-Kelvin effect for hydrogen lies about $-80°\cdot5$ C., a number which agrees very closely with that arrived at by Witkowski from the Rose-Innes equation ($-79°\cdot3$). This agreement makes it worth while considering the further application of this equation to other substances, particularly to air, and the application of the results to the calculation of the critical temperature of hydrogen on the basis of the theory of corresponding states. We have the following data:—

	Temperature of inversion of Joule-Kelvin effect.	Critical temperature.
Air	633° Abs.	133° Abs.
Hydrogen	192°·5 Abs.	—

[1] Kammerlingh Onnes (Leyden *Communications*, xxiii. 1896, 16) pointed out the possibility of liquefying hydrogen by means of Linde's apparatus, and stated the conditions, based on the theory of corresponding states, under which liquefaction can occur.

From this it follows that the critical temperature of hydrogen is 40°·4 or −232°·6 C., which is not far from the value which was found for it experimentally, viz. −234°·5 C. (*loc. cit.*).

From these researches it also appears that it is possible to liquefy hydrogen by the method of free expansion without cooling the gas to −200° C. Provided the heat insulation were sufficiently perfect, it should be necessary to cool the apparatus only to −100°, a temperature which could be attained by means of solid carbonic acid evaporating under reduced pressure, before allowing the hydrogen to expand. M. W. T.

THE RADIANT POINT OF THE APRIL LYRIDS.

THE moon being full on the evening of April 22 this year there is little prospect that the shower of Lyrids will assume prominence as a visible spectacle. It should, however, be carefully looked for on the night following April 21, for, notwithstanding the bright moonlight, it is probable that a few fine Lyrids may be observed if the weather is clear. The maximum formerly occurred on April 20, but 1900 not having been a leap year, the epoch of the shower has advanced one day, and must be looked for on April 21.

There is strong evidence to show that the radiant, like that of the Perseids, moves eastwards with the time, but the Lyrid display is always short-lived and frequently of very feeble character. Moreover, cloudy weather sometimes hides the meteors, or moonlight may practically obliterate them, so that it is extremely difficult to determine the exact place of the radiant on several succeeding nights. The April meteors are rarely as abundant as the August Perseids, though there is always the possibility of a brilliant return of the former as in 1803, when they fell so plentifully that they could not be counted.

I have collected together all the determinations of the Lyrid radiant which I have met with during the last nine years, and they form a curious medley of positions from which it seems impossible to derive any very exact results:—

Date.	Radiant.	Meteors.	Observer.
1893 April 20	257° +46°	47	A. A. Nijland, Utrecht.
	271 +42		
	278 +39		
	292 +39		
April 20–21	267 +37	15	H. Corder, Bridgwater.
	276 +34	10	
April 20–21	266 +37	—	E. R. Blakeley, Dewsbury (reduced by Corder).
	276 +34		
April 20–21	265 +34	—	F. H. Ferrington, Shrewsbury (reduced by Corder).
	275 +32		
April 20	272 +33	7	W. F. Denning, Bristol.
21	273 +33	8	
1895 April 13–27	268 +45	20	H. Corder, Bridgwater.
	270 +29		
	274 +33		
	285 +32		
April 19	269 +37	9	E. R. Blakeley, Dewsbury.
21	274 +36	8	
23	280 +35	4	
1896 April 17–21	263½ +40	8	A. A. Nijland, Utrecht.
	271 +36	14	
April 18–19	271 +36	5	H. Corder, Bridgwater.
	284 +32	—	
April 10–22	275 +38	6	A. S. Herschel, Slough.
1898 April 20	271 +36	22	A. A. Nijland, Utrecht.
	280 +27	13	
April 21–24	272 +41	9	
April 19	268 +36	4	E. R. Blakeley, Dewsbury.
April 19–21	268 +25	5	J. H. Bridger, Farnborough.
April 21–22	273½ +32½	12	W. E. Besley, London.
April 12–22	270 +40	5	A. S. Herschel, Slough.
April 20	268 +37	7	J. A. Hardcastle.
1899 April 19	253 +13	5	A. A. Nijland, Utrecht.
	277 +39	6	
1900 April 20–21	273 +34	8	J. H. Bridger, Farnborough.
April 20–21	266 +26	5	A. King, Leicester.
	274 +33	8	
April 18–24	268 +38	14	A. A. Nijland, Utrecht.
	277½ +40	19	
	302 +54	8	
April 16–21	255 +37	12	A. S. Herschel, Slough.
	255 +27		
	275 +35	23	
1901 April 18–23	266 +30	30	A. S. Herschel, Slough.
	271 +30		
April 12–22	268 +28	32	J. C. W. Herschel, Cambridge.
	273½ +28		
	274½ +33½		
	278 +31		
	278 +37		
	280 +33½		
April 18	266 +33	4	W. F. Denning, Bristol.
April 21	270 +33	25	
April 18–21	261 +36	8	

It will be noticed that some of the observers give a multiple radiant, but that the individual positions compared from year to year do not present a good agreement. At Bristol the radiant has usually been very sharply defined, when the true Lyrids have been sifted from the large number of other meteors directed from showers in nearly the same region of the heavens. The position of the radiant on April 20–21 is at 271° + 33°, and presents a perfect agreement with the radiant point of Comet I 1861, with which the Lyrids have long been supposed to be associated.

Some of the positions included in the list represent showers in Hercules and other contemporary streams. Mr. J. C. W. Herschel, from his observations in 1901, regards the radiant as decidedly multiple, but I believe that further observation will negative this conclusion. There are a considerable number of other meteoric systems in play at the same epoch as the Lyrids, and these, combined with unavoidable errors of observation, must sometimes give rise to apparently scattered radiation and multiple radiants. W. F. DENNING.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

AT the annual graduation ceremonial of the University of Edinburgh on April 11, Prof. MacGregor, who delivered an address, stated that the suggestion to found a laboratory in memory of the late Prof. Tait had taken practical shape, and that a subscription of 1000*l.* towards this object had been received from an anonymous donor.

SCARCELY a week passes without the announcement in *Science* of generous gifts to institutions for higher education in the United States. The following are among the gifts recorded during the past few weeks:—Mr. J. D. Rockefeller has given 1,000,000 dollars toward the general endowment fund of the University of Chicago, and 250,000 dollars for the general needs of the University during the present academic year. He promised a gift to the Harvard Medical School of 1,000,000 dollars on the condition that 765,000 dollars were collected to meet the sum required for the removal and rebuilding of the school. About 600,000 dollars were subscribed in two weeks, and this was quickly increased to 821,225 dollars, which was more than sufficient to make Mr. Rockefeller's gift available. Mrs. Collis P. Huntington has given 250,000 dollars to the Harvard Medical School to erect a laboratory of pathology and bacteriology in memory of the late Mr. Huntington. Mr. J. Stillman has given 100,000 dollars for the establishment of a chair of anatomy in the same school. Mr. Rockefeller has given 5000 dollars to Washington and Lee University, thus completing the fund of 100,000 dollars for a memorial to the late President William L. Wilson, in the form of an endowment for the chair of economics and political science. Barnard College, Columbia University, has added 500,000 dollars to its endowment, one half having been given by Mr. Rockefeller and the other half having been collected as a condition of this

gift. Harvard University has received three large bequests: 450,000 dollars from the late Mr. George Smith, 100,000 dollars from the late Mr. Robert C. Billings, and 100,000 dollars from the late Mr. Jacob Wheelock. Mr. Wheelock also bequeathed 100,000 dollars to Clark University, and Mr. Billings bequeathed 100,000 dollars each to the Massachusetts Institute of Technology and the Boston Museum of Fine Arts. The University of Wooster, Wooster, O., successfully completed a campaign to raise 140,000 dollars in order to secure two large conditional gifts, 100,000 dollars by Mr. Andrew Carnegie and 50,000 dollars by Mr. L. H. Severance, of Cleveland. By the will of Mrs. Lila Currier, 50,000 dollars will go to Columbia University and 100,000 dollars to Yale University upon the death of Mr. Edward W. Currier.

AN address on "The Profession of Teaching," delivered recently at Kendal by the Ven. J. M. Wilson, Archdeacon of Manchester and formerly head-master of Clifton College, has been issued by the Kendal *Mercury and Times*, and it will do a good service by directing attention to desirable objects of education. A school preparation should be of a kind which will foster the desire and develop the power to overcome difficulties; it should give self-reliance and sufficient knowledge of scientific principles to enable the pupil in after life to understand changing conditions and see their trend. Above all, school work should encourage the spirit of inquiry which finds delight in making new observations and experiments with whatever resources are available. The principle upon which Humboldt constructed Prussian education a century ago was: "Whatever we wish to see characteristic of our nation we must first implant in our schools." Remembering this, the teacher's aim should be to give the pupil an observant eye, alert curiosity that inquires into phenomena and their causes, the habit of accurate expression, and varied interests; for then whatever work is afterwards taken up will be satisfactorily done. Archdeacon Wilson strikes the fundamental note of true education in the following remarks from his address:—"The soldier may know all the campaigns of great commanders, from Alexander the Great to Lord Kitchener; but his knowledge avails little unless he has cultivated inventiveness and resource that meets wholly new conditions. The existence of our nation may depend some day on the nerve and originality of the officers of our navy. Every war is a new one; and the next will be utterly unlike the last or the present. It is the same in commerce. The new problems, with combines and international unions, with a shrunken world and new modes of transit, are not like the old. It is the same with agriculture, with mechanical and chemical industries, with engineering. Everything is new, and new every day. It is the same with philosophy and critical studies and theology. It is emphatically the same with statesmanship, municipal and imperial. What utterly new problems in international politics, in international economics and in domestic finance does the world present to-day. Assuredly if we would prepare our scholars for life, the supreme intellectual preparation is found in methods which evoke the faculty, the originality, the mental resourcefulness of our pupils." It is for us to see that the subjects and methods of teaching in our schools are such as promote the development of these qualities, for national progress depends upon them.

SOCIETIES AND ACADEMIES.

LONDON.

Physical Society, April 11.—Prof. S. P. Thompson, president, in the chair.—Dr. R. A. Lehfeldt exhibited an electric heater. The apparatus consisted of a vacuum jacketed glass tube, containing water which was boiled by passing a current through a platinum spiral immersed in the liquid. Tap water is preferable to distilled water, because the small electrolytic action in the former case causes the boiling to proceed quietly. Different temperatures can be obtained by using other liquids.—Mr. Grant exhibited and described an apparatus for vapour pressure measurements. The liquid of which the vapour pressure is required is introduced into the vacuum of a syphon barometer. This is mounted alongside an ordinary syphon barometer, and the upper extremities of both are surrounded by a bath, which can be kept at any desired temperature. The levels of the mercury in the open tubes are then adjusted until the upper mercury surfaces are at the same level. The vapour pressure is then measured by the difference of level in the open tubes. By a simple modification it is easy to investigate the vapour pressure of a liquid in the presence of air. The two chief advantages of the method are (1) the simplification of the temperature correction and (2) the wide range of temperature over which it can be employed with the use of a small bath. Prof. Callendar referred to the advantages of the apparatus, and said that it appeared specially suitable for elementary laboratory measurements.—Mr. J. T. Morris showed an experiment illustrating the use of kathode rays in alternate current work. The usual form of Braun tube was used, the rays falling upon a luminescent screen and forming a blue spot. A solenoid conveying an alternating current was fixed near the tube. The varying magnetic field caused the spot to oscillate about its mean position. To determine the maximum value of an alternating current, a switch should be arranged to rapidly replace the alternating current by a continuous one. The continuous current is then adjusted until the maximum excursion of the spot is the same as before and the value of the current read off from an ammeter in the circuit. For accurate work, the frequency of the discharge from the induction coil exciting the tube should be adjusted until it is almost exactly in synchronism with the alternating current. The unsteadiness of the spot of light in the zero position limits the accuracy of the measurements. Mr. Morris has tried to reduce this unsteadiness by using an earthed aluminium diaphragm instead of a glass one.—Mr. Morris then showed an experiment on the growth of electric currents in an inductive circuit. An E.M.F. of 0·8 volt was applied to a coil wound on a ring-shaped laminated iron core. When the current had attained its steady value, the E.M.F. was reversed and the variations of the current strength shown by an ammeter. About twenty seconds were required for the current to attain its maximum value in the opposite direction. A secondary coil was also wound upon the same core, and the effect produced upon the growing current by the closing of this secondary circuit was shown. Mr. Morris has determined curves of growth for different currents, and he showed how similar curves could be used to determine experimentally the hysteresis loss in transformers.—Mr. Croft showed some apparatus and devices useful in teaching. The method of determining graphically the focal length of a lens from the distances of conjugate foci from the centre was illustrated. The graphical solution of a quadratic equation was also shown. An apparatus for producing and demonstrating the properties of three-phase currents was exhibited and described. Mr. Croft then showed crystals illustrating the five regular solids, and an electric lamp with the filament in one plane useful for optical work. The flatness of a piece of plate glass can be tested with a scribing block. The point is adjusted to touch the glass in one position. By breathing on the glass and moving the block about it is easily seen if the point leaves the surface.

PARIS.

Academy of Sciences, April 7.—M. Bouquet de la Grye in the chair.—Note by M. de Freycinet accompanying the presentation of a work on the principles of rational mechanics.—On the differentiation of Fourier's series, by M. Leopold Fejer. In general the trigonometrical series, which is obtained by differentiating term by term the Fourier's series of a function $f(x)$, is divergent in the cases which occur most frequently in its applications. A special case of Fourier's series is considered in the present paper, which, when differentiated term by term, is always simply indeterminate, and with the exception of the limits 0 and 2π has for its sum $f'(x)$.—On the conditions of stability of automobiles on curves, by M. A. Petot. Formulæ are developed showing the amount of time necessary to pass from one curvature to another. A study of the fundamental conditions arrived at in this paper leads to the conclusion that it is the neglect of these which is the true cause of a number of serious accidents which have been attributed to a faulty steering gear.—Oscillations peculiar to networks of distribution, by M. Brillouin. The theorem deduced by M. Pomey in a recent number of the *Comptes rendus* was announced and demonstrated fifty-one years ago by Helmholtz.—On the relation $L + S/T = Q/T = K$, by M. de Forcrand. The molecular latent heat of volatilisation of ammonia is calculated by the formula of Clapeyron from the data of Regnault, and this is applied to the proof of a theorem that in all physical and chemical phenomena the heat of solidification of a molecule of a gas is proportional to the absolute temperature of volatilisation under a pressure of 760 mm. of mercury.—On the classification of the atomic weights

of neon, argon, krypton and xenon, by M. H. Wilde. The author assumes, without proof, that the atomic weights of this series should be represented by the members of the series $7nH$, where n is 3, 6, or 9. This would give the atomic weights as neon, 7 (9·96); nitrogen, 14 (14); argon, 21 (19·96); krypton, 42 (40·78); and xenon, 63 (64), instead of the experimental numbers given in brackets.—On a type of compounds of glucinum, by M. H. Lacombe. The compounds are of the type A_6Be_4O, where A is the radical of a fatty acid. Particulars are given of the preparation and properties of the formate, acetate, propionate, isobutyrate, normal butyrate and isovalerate. All attempts to prepare the normal salts of the type BeA_2 were fruitless.—On the constitution of the chlorhydrins, by M. Marc Tiffeneau. The author has applied the synthesis of chlorhydrins from magnesium alkyl bromides and mono-chloracetone to determine the constitution of the chlorhydrins obtained from olefines and hypochlorous acid. The rule given by Markownikoff, that in the fixation of HClO on olefines the hydroxyl group attaches itself to the carbon possessing the least hydrogen, as generalised by Krassousky was verified in the experiments described.—On the nitration of furfurane, and on a derivative of nitrosuccinic aldehyde, by M. Marquis. The nitration of furfurane in solution in acetic anhydride opens up the ring with the formation of a monacetin of nitrosuccinic aldehyde. By the action of pyridine upon this, the ring is again closed and mono-nitrofurfurane is produced.—On a new mode of preparation of oxygen, by M. George F. Jaubert. The peroxides of sodium or potassium are compressed with the theoretical quantity either of a soluble permanganate or hypochlorite, or a trace of a nickel or copper salt. Oxygen is produced from these cubes in the cold by the action of water.—Mendel's law and the heredity of pigmentation in mice, by M. L. Cuenot. Up to the present all researches on Mendel's law have been carried out on plants, and it is not known whether this mode of heredity is met with in animals also. Experiments were therefore carried out with white and grey mice, and it was found that the progeny obtained by crossing these was invariably grey. The result of crossing with these grey mongrels was in complete accord with the theory.—On the structure and mode of multiplication of the flagellæ of the genus Herpetomonas, by M. Louis Leger.—On the *Daniellia* of Western Africa and on their resinous products, their relation with the *Hammout* or incense of the French Soudan, by M. Edouard Heckel.—On the seismic influence of the Armorican folds in the north-west of France and in the south of England, by M. F. de Montessus de Ballore.—On a new application of the principle of chrono-photography and on the construction of isonomal barometric charts, serving for the kinematographical study of the general movements of the atmosphere, by M. P. Garrigou-Lagrange. A series of charts showing the isobars over a given area at sufficiently short intervals of time may be regarded as instantaneous photographs representing the several phases of a movement. A series of charts issued by the Signal Office at Washington has been treated from this point of view, and a number of charts obtained which can be used in a hand kinematograph.

DIARY OF SOCIETIES.

THURSDAY, April 17.

Royal Institution, at 3.—The Oxygen Group of Elements: Prof. J. Dewar, F.R.S.

Society of Arts, at 4.30.—Recent Developments in Punjab Irrigation: Sidney Preston.

Linnean Society, at 8.—The Anatomy of Todea with Notes on the Affinity and Geological History of the Osmundaceæ: A. C. Seward, F.R.S., and Miss Sybil O. Ford.—On the New Zealand Phyllobranchiate Crustacea, Macrura: G. M. Thomson.

Chemical Society, at 8.—Oxonium Salts of Fluoram and its Derivatives: J. T. Hewitt and J. H. Tervet.—The Influence of certain Acidic Oxides on the Specific Rotations of Lactic Acid and Potassium Lactate: G. G. Henderson and D. Prentice.—(1) The Amounts of Nitrogen as Ammonia and as Nitric Acid, and Chlorine in the Rain-water collected at Rothamsted; (2) The Amounts of Nitrogen as Nitrates and Chlorine in the Drainage through uncropped and unmanured land: N. H. J. Miller.

FRIDAY, April 18.

Royal Institution, at 9.—The Autocar: Sir J. H. A. Macdonald.

Epidemiological Society, at 8.30.—Smallpox Hospitals and the spread of Infection: Dr. Thresh.

Institution of Civil Engineers, at 8.—The Erewash Valley Widening and Toton Sidings: H. C. M. Austen.

Institution of Mechanical Engineers, at 8.—The Standardisation of Pipe Flanges and Flange Fittings: R. E. Atkinson.

MONDAY, April 21.

Victoria Institute, at 4.30.—Iceland, its History and Inhabitants: Dr. J. Stefansson.

Society of Arts, at 8.—Glass for Optical Instruments: Dr. R. T. Glazebrook, F.R.S.

TUESDAY, April 22.

Royal Institution, at 3.—Recent Methods and Results in Biological Inquiry: Dr. A. Macfadyen.

Institution of Civil Engineers, at 8.—*Discussion*: Locomotive Firebox Stays: F. W. Webb.

WEDNESDAY, April 23.

Institution of Civil Engineers, at 8.—"James Forrest" Lecture: Metallurgy in Relation to Engineering: Sir W. C. Roberts-Austen, K.C.B., F.R.S.

Society of Arts, at 8.—Opto-technics: Prof. Silvanus P. Thompson, F.R.S.

THURSDAY, April 24.

Royal Society, at 4.30.—*Probable papers.*—On Skin-currents. Part III.—The Human Skin: Dr. A. D. Waller, F.R.S.—Antarctic Origin of the Tribe Schœneæ: C. B. Clarke, F.R.S.—A New Interpretation of the Gastric Organs of *Spirula Nautilus* and the Gastropods: J. E. S. Moore and W. B. Randles.

Royal Institution, at 3.—The Oxygen Group of Elements: Prof. J. Dewar, F.R.S.

Institution of Electrical Engineers, at 8.—Problems of Electric Railways: J. Swinburne and W. R. Cooper. (Adjourned discussion).—Form of Model General Conditions, for use in connection with Contracts for Plant, Mains, and Apparatus for Electricity Works. As drafted by a Committee.

FRIDAY, April 25.

Royal Institution, at 9.—X-Rays and Localisation: Dr. J. Mackenzie Davidson.

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THURSDAY, APRIL 24, 1902.

PRACTICAL ZOOLOGY FOR BEGINNERS.

Leitfaden für das zoologische Praktikum. Von Dr. Willy Kükenthal. Zweite, umgearbeitete Auflage. Pp. viii+304; 169 illustrations. (Jena: Fischer, 1901.) Price 7 mk.

THE character of a work on practical zoology for beginners will differ fundamentally according to the particular point of view of the author. If the attainment of a thorough grasp of the organisation of a few animals be held to be the best means of developing the capabilities of a beginner, we are naturally led to the type-system of which Huxley was the pioneer, and his "Practical Biology," used conjointly with Prof. Howes' biological atlas, will remain a classic.

The German school, on the contrary, has developed another system; it gives the beginner at once a general outline of the animal kingdom, and concurrently a large number of animals are superficially examined.

There are arguments that can be advanced for either system. The broad outline of the animal kingdom provided by the German laboratories tends to arouse the interest of the student, and it is undoubtedly worth while to sacrifice much to accomplish this end; for without intelligent interest very little need be expected from the pupil. On the other hand, it must be admitted that such a system of instruction can too readily degenerate, and the result on the student's mind is likely to be but a confused assemblage of ill-digested facts. It may well be doubted whether a cursory glance over the whole animal kingdom constitutes as valuable a training for the future investigator as a thorough study of a few well-selected types.

In our universities we have to satisfy the needs of three classes of students:—(1) those seeking a general scientific education, (2) the future investigator and specialist in zoology, (3) the future medical man. The endeavour to deal with all three classes of students in the same manner cannot be wholly satisfactory; but a student beginning the study of zoology will probably not at first have the intention of becoming an investigator, and it would in practice be very difficult, or impossible, to separate the first two classes of students. Accordingly we must be content with arranging separate courses for the general student and the medical student.

The work by Dr. Kükenthal is primarily intended as a practical aid in the laboratory for the general student beginning his subject. The opinion as to how far the author has succeeded in his difficult task will greatly depend on the particular bias of the individual teacher. That the book has had a certain measure of success in Germany is evinced by the fact that the first edition appeared only three years ago.

The book begins with a rather meagre account of the apparatus required and of the general manipulation of the microscope. The body of the work consists of twenty chapters, each of which is divided into three parts:—(1) practical instruction in manipulation and the material required, (2) an outline sketch on the subject of the chapter, (3) a special description of one or more types.

The first chapter deals with the elements of histology. In the outline sketch, the nature of a cell and the general characters of tissues are shortly described. In the special description an amœba, white blood-corpuscle of the frog, egg of mussel and examples of the various tissues are very briefly introduced. The fact that a nucleus is capable of dividing is only just mentioned, although surely even a beginner ought to be shown preparations illustrating karyokinesis.

Each of the remaining chapters deals with one group or several allied groups of animals, and at the beginning of every phylum there is given a descriptive classification. The chapter on the Protozoa begins with an excellent account of events taking place in a hay-infusion, then in a single page the general characters of the group are summarised, while in the special description of types we find representatives of most of the more important classes of Protozoa; but the Foraminifera and Sporozoa are omitted. The Hydrozoa are also dealt with satisfactorily; the special descriptions include the following instructive series:—Hydra, Tubularia, Cordylophora, Clava, Tiara, Obelia, Liriope, Aurelia and Nausithoë.

The difficulty of such comparative treatment increases greatly as we pass to the more complicated Metazoa, and the author's accounts of the various groups tend to be decidedly unequal. Thus there is a brief description of the groups Bryozoa and Chætognatha, and among the Mollusca the genera Chiton and Sepia are included; yet of the Crustacea there is only Daphnia and a rather inadequate account of the crayfish. Also, in a book of this character the student might surely be somewhat further introduced to such larval forms as Trochosphere, Nauplius and Pluteus than by the mere mention of their names.

The chapters on the Vertebrata are the least satisfactory of the book. In some seventy pages we find Amphioxus, perch, frog, lizard, pigeon and rabbit. It may be doubted whether such an abridged account could be of much use to the beginner, and the descriptions take more after the method of a text-book than of a practical guide for the student in the laboratory. Inserted here and there are a few directions as to dissection, but without the constant aid of a demonstrator it is certain that an ordinary student could make but little of them. There are practically no figures of the vertebrate skeleton, blood-systems or nerves.

With the exception of the vertebrate section, the book is well illustrated with good figures, which appear in most cases to have been selected with much care. The appearance of one incorrect figure may be noticed. The series of diagrams after Boas (Fig. 38) showing the supposed stages in the degeneration of the medusa into a sporosac do not correspond to facts. The sporosac represents the degeneration of the whole of the medusa, and is not simply the persistent manubrium. There are a considerable number of original sketches which bear the impress of being drawn directly from dissected specimen, and are consequently especially useful to the student. The original drawings of the starfish and sea-urchin deserve particular mention.

In the opinion of the reviewer, we are in need of a compromise between the English and German methods of dealing with the beginner, in fact, a work intermediate in character between Huxley's "Practical Biology" and

the present book. Such a work need not necessarily greatly exceed the "Leitfaden" in bulk, for the classifications, excellent though they are, and the general summary of the different groups might safely be left to the lecturer or text-book. This, together with the omission of some of the less important groups, would allow space for more practical instruction in manipulation and for a somewhat fuller treatment of most of the different types described, more especially of those of the vertebrates.

On the whole, it may be said that the present work bears the stamp of originality; the style is clear and the descriptions are terse and generally accurate, and if in a future edition Dr. Kükenthal should see fit to remodel his book in such a manner as suggested, it would be welcomed in our colleges as a valuable and much-needed aid to the beginner in the laboratory. E. W.

FERMENTS AND FERMENTATION.

Ferments and their Actions. By Carl Oppenheimer, M.D., Ph.D., and translated and amended by C. Ainsworth Mitchell, B.A., F.I.C. Pp. xii + 343. (London: C. Griffin and Co., Ltd., 1901.) Price 7*s.* 6*d.* net.

THERE are few subjects more interesting and at the same time more difficult than the study of ferments and their actions. But many students, and not a few original workers, shrink from the study of ferments owing to the great complexity of the subject. A book, therefore, which aims at treating the subject in a concise and intelligible manner must inevitably attract a wide class of readers.

The author very properly points out that it is impossible to understand any of the problems relating to fermentation unless there be formulated some definition of a ferment *per se* and some simple conception of the process of fermentation. With this object, in the second chapter the writer gives us what he considers a simple definition of the notion ferment:—

"A ferment is the material substratum of a peculiar form of energy, which is produced by living cells and adheres more or less firmly to them without having its activity bound up with the vital process as such; this energy is in a condition to bring about the liberation of latent (potential) energy of chemical substances and its conversion into kinetic energy (heat, light), in such manner that the chemical substance is so changed in the process that the new substance or the sum of the new substances produced possesses a smaller potential energy (*i.e.* a smaller heat of combustion) than the original substance."

It must be confessed that, however scientifically perfect this definition may seem to be, it will not impress the average reader with the idea of its simplicity. But the distinguished author goes on to elucidate the different heads of this definition, and in so doing makes clear even to the lay reader many vital points bearing on this difficult subject.

The following frank acknowledgment of the ignorance which underlies all our conceptions of the ways and means by which fermentative processes develop their activity is worth quoting in full:—

"We must simply resolve to regard fermentative actions as special phenomena of the ominous 'catalytic' processes from which their differentiation is required by the fact that they are produced by living cells. Catalytic action is nothing more than a scheme of despair under which we may group chemical reactions which, while possessing a certain similarity in their course, cannot, without further knowledge, be explained by our simple chemical theories. With the advance of our knowledge, we have naturally been able to assign many phenomena which were formerly regarded as catalytic to simpler chemical laws, so that this useful idea has undergone a considerable limitation in its applicability. At the same time we must not forget that in its essence even the theory of simple chemical decompositions and of chemical affinity is, as regards our theoretical knowledge, only one vast enigma; that we have only been much longer accustomed to deal with these conceptions as indispensable fundamental axioms without being able to approach them otherwise than metaphysically, which also holds good in a still wider sense of the conceptions of matter and force in general."

Chapter iii., on the chemical nature of ferments, is well worth the most careful perusal. It is the fault of the subject, not of the writer, that it makes stiff reading. In this chapter the author points out the uselessness of such vague expressions, which lead nowhere, as that there are in ferments "fragments of protoplasm" endowed with "residues of vital force." Gautier's dissolved cell hypothesis is very ably discussed.

The influence of external factors on the action of ferments is concisely dealt with in chapter iv., and chapter v., on the mode of action of ferments, is perhaps the most interesting in a book all of which is full of matter of absorbing interest and importance.

But it is impossible within the scope of this short review to touch on more than a fraction of the points in the work, which will repay study by both the layman and the expert in this subject.

A. C. HOUSTON.

OUR BOOK SHELF.

Civil Engineering as applied in Construction. By Leveson F. Vernon Harcourt. "Longmans' Engineering Series." Pp. xv + 624; with 368 illustrations. (London, New York and Bombay: Longmans, Green and Co., 1902.) Price 14*s.* net.

THIS book, as the author states in the preface, consists of a concise grouping together of the various branches of constructive civil engineering.

A book that attempts to deal in a single volume with the vast range of subjects embraced in civil engineering must necessarily be more in the nature of an encyclopædia than a series of treatises on the subjects dealt with; and the descriptions of the works selected as examples are, therefore, necessarily limited to as small a space as is possible for the elucidation of the various subjects, and for indicating the practice followed in the execution of constructive works; but what is given is of a thoroughly practical character, and the subjects are very fully illustrated. The author has not taken up space by dealing with theories, or by giving elaborate formulæ.

The information given has been derived to a very large extent from *Proceedings* of the Institution of Civil Engineers, of which the author gives full acknowledgment.

The book should be of great use to an engineer when called upon to deal with constructive works of a character that he has not had previous experience of, as indicating the various ways in which constructive requirements have been treated. To students of engineering it will be of value in directing attention to the principles forming the

basis of design and construction, and by indicating the different ways in which these principles have been applied in practice.

The volume may, in fact, be regarded as a guide-book to what has been done, but its usefulness would have been enhanced if more frequent references had been made to the sources from which complete information on the different subjects could be obtained, or if a list of the works in which the subjects have been treated had been given at the end of each chapter. It is true that in such matters as harbours, docks and canals, with which the author is most conversant, the references from which the information is taken are plentifully given; but these are principally to the author's own works, and no mention is even made of the works on these subjects that have been published within the last few years in "Longmans' Engineering Series," of which this book forms part.

Besides a general introduction, the subjects are dealt with under five heads, and include (1) materials employed in construction; preliminary arrangements for carrying out work; excavation; dredging; pile-driving; cofferdams; foundations; piers of bridges; roads and street-paving. (2) Laying out and formation of railways; bridges; viaducts; tunnels; permanent way; light railways and tramways. (3) Control and regulation of rivers; canals and canalised rivers; ship canals; and irrigation works. (4) Docks, river quays, harbour works; lighting coasts and channels; land reclamation and coast protection. (5) Sanitary engineering, including water supply and sewerage works.

Rural Reader—Senior. By V. T. Murché. Pp. 292. Price 1*s.* 9*d.*

The Teacher's Manual of Object Lessons for Rural Schools—Senior. By V. T. Murché. Pp. xxiii+396. (London: Macmillan and Co., Ltd., 1902.) Price 2*s.* 6*d.*

THE schoolmaster in the country is just now very much in want of a text-book to guide him in giving that kind of instruction which is variously termed "nature knowledge" or "rural economy"; such elementary observation and reasoning applied to common things, as will stimulate the child's mind and yet serve as an introduction to agriculture or horticulture later. Mr. Murché was ready with two text-books very soon after the circular from the Board of Education in 1900, and now comes forward with two more for senior children, a reading book for school use and a parallel series of object lessons set out for the teacher's benefit.

The scope of the books is extensive enough—a little chemistry and botany, a few discourses on farming, then comes a considerable section on insect life, with chapters on fishes, reptiles, trees and ferns to the end. The get-up is excellent, nice type and plenty of pictures, so that any child will enjoy the varied course of the reader, and the teacher may get many excellent hints from the object lessons. But how fatally does the author miss the whole spirit of the work, which is to make the child see and think and find out things for himself. From beginning to end of the book the child is being told in dogmatic fashion scraps of information about natural objects of the most unequal degree of importance. The book is a typical compilation; in each subject the man who knows will detect, if not mistakes, yet that want of proportion, that emphasis in the wrong place, which mark the writer at second hand.

For example, on p. 63 the children are made to compare the flower of the Deadly Nightshade, *Atropa*, with the potato flower, to show them how a garden plant may have wild relations. In the first place, there is little superficial resemblance between the flowers, and *Atropa* is a really rare and casual plant in England, whereas every hedgerow contains the "Woody Nightshade," poisonous enough and with flowers that are unmistakably the fellows of the potato flower. Again, we notice on p. 127 an account of the mole cricket, with a picture; how many collectors, not to speak of children, have ever found a mole cricket? And so the book goes on through the whole gamut of animated nature; our feeling in the end is one well known to examiners, "I suppose I must allow some marks for this, but——" We have not yet found the text-book for country schools, and we are afraid that Mr. Murché's is just a sufficiently middling substitute to block the way of the real article when it comes.

A. D. H.

Poultry Management on a Farm. By Walter Palmer, M.P. Pp. 94. (Westminster: Archibald Constable and Co., Ltd., 1902.) Price 1*s.*

THE object of this work is to show that poultry in considerable numbers can be kept on an ordinary farm with profit. Mr. W. Palmer, M.P., on land of about 200 acres, has established a poultry department. 350*l.* have been expended in buildings and the necessary appliances, a skilled manager with three assistants have been appointed, and the results of three years' work are very fairly given in this well-printed and well-illustrated, but very cheap, volume. Whether the results are such as will induce many other agriculturists to go into the pursuit or not may be regarded as doubtful, but the volume is well worthy the attention of those who are interested in the matter. Poultry farms pure and simple have long been known to be visionary, those institutions at present going under that name not being utility poultry farms, but places for the rearing and sale of fancy stock at fancy prices. Mr. Palmer is an enthusiast in his subject, and it is needless to say that his work presents the results of his experiments in the most favourable light, but this is obviously done with a good motive and in an exceedingly truthful manner. Many practical farmers would, however, object to his figures. Nothing is charged for the annual depreciation and wear and tear of the plant. The annual value of the manure of the two thousand birds is estimated at 100*l.* Moreover, the author states that if the ninety thousand farms in England were all to keep poultry on the plan recommended by himself, the profit arising from this source would be no less than four and a half millions a year to the British farmer. These statements will be differently estimated by different readers.

Lectures on the Lunar Theory. By John Couch Adams M.A., F.R.S. Edited by R. A. Sampson, M.A Pp. 88. (Cambridge University Press, 1900.) Price 5*s.*

WE are glad to see that the famous lectures of Adams on the lunar theory have been published so as to be readily accessible to all. They have been well edited and most lucidly presented to the reader. Prof. Sampson naturally, however, did not feel at liberty to extend the subject-matter of the lectures, so that the work remains in a slighter form than Prof. Adams would, perhaps, himself have cared to publish it.

This being so, we are led to ask—What class of readers does this book specially cater for? We do not think the students, for the book cannot compete with Dr. E. W. Brown's treatise, nor would it be of any great value to the calculator who should wish to develop afresh correct expressions for the moon's coordinates, for the chief difficulties here consist in the correction of approximate solutions, a section to which only four pages (pp. 30–33) is devoted in the present work, and, moreover, the action of the planets is not considered. Perhaps, then, the class that will find this book most interesting are the astronomers, who from time to time want to refer to small portions of the theory and obtain numerical values for some of the quantities that occur. This was, perhaps, not the design of the work, but we can recommend it as serving this purpose thoroughly.

Lectures and Essays by the late William Kingdon Clifford, F.R.S. Edited by Leslie Stephen and Sir Frederick Pollock. 2 vols. Pp. 410, 342. (London: Macmillan and Co., Ltd., 1901.) Price 10*s*.

It is neither upon his popular lectures nor upon his crude essays in metaphysics that Clifford's permanent reputation is based. But it is not surprising that they still find numerous readers; they are so free from pedantry, so engagingly frank, so evidently the work of a man who sought truth with a really passionate desire. We may smile at Clifford's theory of "brain-stuff," which is easily demolished by the very same kind of criticism which he himself applied to "The Unseen Universe"; we may feel justly astonished that a mind so penetrating in many ways should believe that consciousness is a complex of elementary feelings, which can separately exist as things in themselves; we may regret the occasional bitterness of his invectives, even while we remember that they were inspired by a hatred of priestcraft and superstition. But with all this, when we turn again to these fresh and stimulating pages, and when we read once more Sir Frederick Pollock's graceful and generous introduction, we can understand how Clifford charmed and impressed his contemporaries, and how keen was their sorrow at his premature death. It is, perhaps, not altogether fanciful to compare Clifford's fate with that of Robert Louis Stevenson; in each case a reaction has followed the too partial praise of admiring friends, and this disparagement is again being corrected by a more dispassionate criticism.

Teoria delle Funzioni Analitiche. By Giulio Vivanti. Pp. 432. (Milan: Ulrico Hoepli, 1901.) Price 3 lire.

"A pocket guide to the Theory of Functions," may strike many pure mathematicians as being a rather startling innovation. But the rate at which mathematical knowledge is added to every year makes it increasingly difficult for a mathematician to acquire a thorough acquaintance of more than a very limited range of study, and if the physicist, for example, has to derive his information on the theory of functions from large treatises and scattered literature, "life is too short" and the work is crowded out by other matters.

The book is divided into three parts, the first containing the elements of the theory of groups, the second the general theory of analytical functions, while the third contains a sketch of certain recent developments of the theory of functions. Prof. Vivanti bases his treatment on Weierstrass's methods. At the end is a list of 218 books and papers dealing with the subject, all for the very small price of half-a-crown.

It is much to be wished that a reaction may be set on foot in this country against the over-elaboration and specialisation of mathematical text-books by the publication of a series of small handbooks similar to this little Italian treatise. The need for a change of this kind is well illustrated by a copy of the 1860 edition of Routh's "Rigid Dynamics," which the present writer has just acquired. It bids fair to be much more useful in teaching a certain class of student than the modern large two-volume editions.

Graduated Exercises in Elementary Practical Physics. By C. J. Leaper. Pp. iii + 264. (London: Biggs and Co., 1901.) Price 2*s*. 6*d*.

This contains the usual elementary exercises in physics, and it is not obvious what special advantages it offers. Many of the diagrams are very bad, and the printing is poor. Examples are given for the students to follow; thus we find the product in Boyle's law carried to six significant figures, and the latent heat of fusion of ice to five figures. How often are we to cry out against this?

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* Nature. *No notice is taken of anonymous communications.*]

The Education Bill.

The suggestion in your editorial memorandum last week on this subject is one for which there is a remarkable precedent in the history of educational controversy. That suggestion is to the effect that, having regard to the complexity of the subject, to the fact that the urgent need of our time is the organisation of secondary and higher instruction, while the condition of our primary instruction is, on the whole, satisfactory and but for the demands of the voluntary schools would not require any material change at all, it would be well to divide the Bill into two parts and to press forward during the present session the enactment, with due modifications, of that part which affects intermediate and scientific education, and so to leave the part relating to elementary education for fuller consideration another year.

This course would be precisely similar to that adopted by Mr. W. E. Forster in 1869, the year before the Elementary Education Act. He had been a member of the Schools Inquiry Commission, which had recently issued a memorable and most comprehensive report, the work largely of the late Lord Lyttelton and the present Archbishop of Canterbury. As Vice-president of the Council, he introduced the Endowed Schools Bill, which was designed to deal with the whole problem of secondary as distinguished from elementary instruction. The Bill was divided into two parts, the former providing for the urgent need of the moment, the reform of the ancient and often obsolete and useless endowed foundations, and the latter constituting central and local authorities for the coordination and improvement of all classes of secondary schools—private, proprietary and municipal—for the registration of teachers, for the provision of needful schools, and for the construction of a coherent system of secondary education for the whole country. But it happened then, as it is happening now, that such a large and far-reaching proposal touched many interests and involved many difficulties, and that it proved impossible to pass the whole Bill in one session. So Mr. Forster wisely abandoned the second part of the Bill, and resolutely secured the passing of the first. The Endowed Schools Act thus simplified and placed on the statute book is still in force, and has proved to be one of the most beneficent of modern Acts of Parliament. It created a special Commission, with power to inquire into the history and resources of educational foundations, to revise and modernise their statutes and deeds of gift, to reform the governing bodies, and to secure the permanence and increased public usefulness of educational endowments generally. Other attempts have been made in subsequent years to deal piecemeal with the larger projects of educational reform contemplated by the Government of 1869; but it remains on record that if an attempt had been made to enforce the enactment of the whole measure, the Endowed Schools Act, which has proved of such signal public service, would never have been passed.

Without renewing any discussion as to the merits or demerits of the new Bill, it may interest your readers to be reminded of the precedent thus set more than thirty years ago. If that precedent were followed in the present case, it would at least give an opportunity to the newly constituted local authorities to deal at once with technical and secondary education, and thus to gain a new title to public confidence. The public would then be enabled to judge, after one or two years' experience, of the expediency of entrusting to these bodies the larger and more difficult task which the present Bill proposes to hand over to them—the virtual reconstruction of the whole existing system of elementary education. J. G. Fitch.

Athenæum Club, April 22.

I find myself in entire agreement with the views expressed by Principal Lodge in the last number of Nature. And if any practical illustration were needed to support them, I think ti is afforded by the invaluable work which has been done for secondary education in the county of Surrey.

Until the County Council took the matter up, the educational destitution of western Surrey as regards secondary schools was

deplorable. There was no provision for either carrying on the education of the best boys at the primary schools, or for educating the large class of sons of artisans and others for whom the primary schools were insufficient and such private-adventure schools as existed altogether inadequate. As a governor of the Richmond School I am able to speak with confidence of the remarkable success which has attended its establishment.

As regards Surrey I do not see, therefore, that the Bill will put us in a much better position than we are at present. But the present crying need is that primary education should be dealt with on the same lines. It would, in my opinion, be a real disaster if the part of the Bill relating to it were to be dropped, as has been proposed in these pages.

In the Borough of Richmond the arrangements for primary education can hardly be described as other than chaotic. I am by no means persuaded that the establishment of a School Board would make matters much better. We might gain something in one direction at the cost of losing all chance of coordinating our arrangements for primary with those for secondary instruction. The one should dovetail into the other, which it is little likely to do if they are in different hands. I am wholly at a loss to see why an organisation which has solved one problem should not be able to solve both.

Kew, April 21. W. T. THISELTON-DYER.

The Dangers of Coral Reefs to Navigation.

IN consequence of a paper which I recently read before the Royal Geographical Society on "The Formation of the Maldives," I have received several letters from officers of the mercantile marine. These lead me to believe that the danger incurred by too closely approaching coral reefs and islands is not generally perceived. Further, I have myself seen large passenger steamers coasting round the south of Minikoi Atoll within 300 yards of its encircling reef. Indeed, one large liner was so close in that the look-out man at the mast head could not have failed to see the bottom. The practice of approaching so near *where unnecessary*—to enable passengers to get a good view of the land and reef—is one attended with considerable danger and greatly to be deplored.

It is generally known that most reefs on their seaward faces slope gradually from their edges to 25–50 fathoms, and then more steeply to 100–200 fathoms. The breadth of this inner slope or reef-platform varies in the Maldives and Laccadives from half-a-cable to half-a-mile. Its surface, especially down to 20 fathoms, is extremely uneven, great buttresses and masses of rock arising to within a few fathoms of the surface. Such rocks are very generally covered with green corals or dark-coloured, calcareous algæ, so that except in absolutely calm weather they may not readily be perceived. Further, isolated coral heads—separate coral colonies—may grow up on any rocks within about 20 fathoms of depth almost to the surface. I have in Maldivan lagoons been twice stranded on such heads, arising respectively from 8 and 14 fathoms. At the seaward ends of passages into atolls of the same group, where the conditions are not very dissimilar to those outside atolls, similar heads not infrequently grow from 15 fathoms or even deeper to within 2 or 3 fathoms of the surface. The tops of these are often only a few yards across, so small indeed that they may be easily missed in any survey, however careful.

It is apparent then that dangerous rocks may arise on any part of the reef-platform. The outer steep slope is often so precipitous that the edge of this platform is only separated by a few yards from the 100-fathom line. The latter is usually very carefully charted, but for safety liners and deep-draught steamers should pass well to seaward of it. J. STANLEY GARDINER.

Gonville and Caius College, Cambridge, April 20.

Rearrangement of Euclid Book I.

I HAVE always taken it for granted that the *chief*, if not the *only*, objection to Euclid's Elements as forming an introductory course in geometry is that a very large proportion of beginners *are unable to work riders for themselves*, and consequently they are reduced to the necessity of merely reading up the propositions in such a way as to be able to reproduce them more or less mechanically in the examination room.

This difficulty does not exist in algebra because, taking simple equations as an instance, it is easy by varying the numerical coefficients to furnish the beginner with an unlimited variety of *numerical examples* which, being all solved by the *same* method, do not present such difficulties as Euclid "riders," each of which is practically a separate problem or theorem requiring a *different* method of solution.

The wide gap between the reproduction of bookwork and the devising of methods of solving riders presents a serious obstacle to the progress of beginners. What I at present fail to see is how the gap would be bridged over either by a rearrangement of the propositions in Book I. or by any of the substitutes for Euclid which have been suggested of recent years, and I much hope that this letter may be the means of eliciting fuller information on the direct connection between the present unsatisfactory state of affairs and the proposed remedies. G. H. BRYAN.

Bangor.

The Morphology of the Pleuronectidæ.

ABSENCE from Liverpool has prevented me replying to Mr. J. T. Cunningham's criticisms of the work on the anatomy of the Plaice recently published by Mr. Johnstone and myself. The passage which Mr. Cunningham chiefly objects to is as follows:—"If [the dorsal fin] occupies the mid-dorsal line of the head, then it is obvious that the left eye must have actually passed through the substance of the head to reach the ocular side. This supposition, absurd as it may seem to us now, was in fact believed by such an observer as Steenstrup." In "correcting" this passage Mr. Cunningham says:—"The truth of the matter is that Steenstrup did not believe any supposition, absurd or otherwise, on the subject, but stated from actual observation that in certain larval Pleuronectidæ the eye of one side passed through the tissues of the head and emerged on the other side. The form in question was long known as Plagusia, and is now known to be the larva of Rhomboidichthys. The truth of Steenstrup's observations was fully confirmed by Alexander Agassiz at Newport, R.I."

Now on referring to Steenstrup's memoir again I find that it is Mr. Cunningham himself who has misunderstood that author. For whilst Steenstrup certainly observed an *apparent* passage of the eye through the head, he also *supposed* that the eye passed actually through the tissues of the head itself, as apart from those of the dorsal fin, which cannot, of course, be considered a part of the head. This is the theoretical deduction that I characterised as absurd, since it is needless to say that neither Steenstrup nor Agassiz ever witnessed so impossible a phenomenon. Indeed, both Agassiz and Ehrenbaum state, quite correctly, that the migrating eye lies between the base of the dorsal fin and the roof of the head, and therefore only "apparently passes through the head" (Agassiz).

The significance of the asymmetry of "Plagusia" has been made quite clear by the short but important paper recently published by Nishikawa. This paper renders almost certain the deduction which I think most morphologists would have drawn from Agassiz's work, viz., that the metamorphosis of Plagusia is in all essential respects similar to that of the Plaice. The fact that here the dorsal fin grows forwards *before* metamorphosis sets in has not affected the fundamental character of the torsion, for the migratory eye is, of course, *morphologically outside the head during the whole of its transit*. Nishikawa says, and very truly:—"In every case, the passage of the eye from one side to the other in flat fishes is morphologically along the dorsal surface of the head." The statement, therefore, to which Mr. Cunningham takes exception is absolutely correct, and it seems that, living remote from scientific libraries and doubtless unable to consult the original, Mr. Cunningham's memory has led him astray.

Mr. Cunningham's second point involves an academic issue that I must leave others to discuss. Prof. Mitsukuri once remarked to me, in connection with his having undertaken some systematic work, that he had temporarily abandoned the morphological pursuit of similarities, in favour of the systematic search for differences. Thus, whilst many systematists, with their taxonomic details, would widely separate the Pleuronectidæ from the Gadidæ (although Jordan and Evermann, whom we followed, do not), most morphologists, taking a much broader if less precise view of the question, would say that a Plaice was simply an asymmetrical cod-fish. And both may be right judged by their own standards. F. J. COLE.

University College, Liverpool, April 14.

Swarm of Velella.

THE brief note from Alassio by Mr. Isaac Thompson on the extent and density of a swarm of Velella off that coast this month recalls to my mind seeing a similar scene on each of two occasions when staying at that place in April. On each occasion of the swarm there was, as I well remember, a strong wind from the east; on each the shore became so thickly strewn with the organisms as to become unpleasantly odorous from their decay. CH. S. SHERRINGTON.

Felixstowe, April 19.

REFERRING to your correspondent's letter on the swarms of this little marine animal that strewed the shores of the Riviera di Ponente early in April, I was at Alassio and remarked that the wind had been easterly for some days before the advent of the swarm. Alassio is situated on a sandy bay facing the east; on the western side of the bay, two miles away, lies a fishing village called Laiguelia; here the Velella were in far greater numbers, thickly piled on the shore, thinning off gradually towards Alassio, while beyond Alassio, at the extreme eastern end of the bay, the Velella were comparatively thinly scattered on the sand. The clear horny oval disc over the little colony of polypes, with its diagonally-set, triangular sail, places Velella at the mercy of the winds; a shoreward wind blowing for several days must end in the wreck of the little "Barca di San Giovanni" (boat of St. John), as the Alassian fishermen call it. I am told it is usually in early June that the swarms are swept ashore, and then in immense numbers—far more than strewed the bay this April. The prevailing wind in summer at Alassio is easterly. ROSE HAIG THOMAS.

Hotel Palais d'Orsay, Paris, April 21.

Habits of the Gar-fish and Mackerel.

BEYOND the fact that the bodies of other fish are occasionally pierced by them, no evidence seems to exist concerning the special function of narrow elongated jaws of the gar-fish (*Belone vulgaris*, Fleming). These fish are usually captured in drift nets along with mackerel, and there appears to be some vague idea among fishermen that they either guard or guide the mackerel shoals. In the cases on record where a mackerel or other fish has been pierced by the gar-fish, the upper jaw of the latter has usually been found broken off and remaining in the wound. This fact is inconsistent with the supposition that the normal function of the elongated beak is to be used as a spear, and there is no evidence that the gar-fish feeds on the flesh of large fishes.

Examination of the beak itself shows that the end of it is formed by the tip of the lower jaw, which is about half an inch longer than the upper. This tip is not hard and sharp, but soft and blunt; the upper jaw is narrower, and ends in a harder and sharper point. Thus the lower jaw is by no means adapted for use as a piercing weapon. Recently I opened the stomach of one of these fish landed at Newlyn, and found in it the partly digested remains of a slender silvery fish, which at the time I could not identify. The next day I opened a number of mackerel and found in some of them copepods and amphipods, but in nearly all remains of fish food, and in one, two specimens of the smaller sandeel (*Ammodytes tobianus*) only slightly digested. I was then able to satisfy myself that the fish on which the Belone had been feeding was also the sandeel, and I was impressed with the similarity in the structure of the jaws between the Belone and its prey. It then occurred to me that the proper function of the beak of the Belone was to penetrate the sand in pursuit of sandeels. The latter fish burrow into sand by means of the projecting lower jaw, and it is evident that the beak of the Belone is as well adapted for probing the sand, finding and seizing the sandeel, as is the beak of the woodcock for probing soft ground in search of worms and burrowing insects. The flexible tip of the fish's beak is doubtless a sensitive tactile organ, while the narrow toothed upper jaw is eminently fitted for seizing and holding the slippery and agile prey.

It seems very probable that special adaptation for the pursuit of sandeels in the sand explains, not only the peculiar beak of Belone, but also the elongation and structure of the whole body. Narrowing and elongation of the body are related in fishes and many other animals to creeping or burrowing habits. Probably, not merely the beak, but the greater part of the body of Belone also is thrust into the sand in pursuit of its prey, and this would explain why the dorsal and ventral fins are placed far back, so that the propelling apparatus remains in the water, and why the abdominal region is nearly cylindrical, with a somewhat flattened ventral surface, without dorsal or ventral ridges.

The fact that the mackerel were also feeding on sandeels further suggests a special reason for the association between mackerel and gar-fish. It is true that many predaceous fish eat sandeels when they can get them, but the jaws of the mackerel are not specially fitted for dislodging sandeels from the sand. In the early part of the year mackerel feed largely on copepods and other pelagic animals, having long, close-set gill-rakers through which they can strain the sea-water, like clupeoid fishes. In summer and autumn mackerel feed chiefly on small fishes which swim near the surface, such as the young of sprats, herring, gadoids, &c. But it seems probable that mackerel accompany the gar-fish in order to feed on the sandeels which leave the sand in their efforts to escape from their special enemy.

I have not yet made any observations on the food or habits of the saury-pike (*Scomberesox saurus*), but it is probable that, as in the case of Belone, injury to pilchards or other fishes by the beak of this fish is rather accidental than intentional. Couch and Matthias Dunn believed that the saury-pike was the enemy of the pilchard, and that it attacked the latter. When a number of both kinds of fish were enclosed in a seine, many of the pilchards had their eyes or bodies pierced by the beaks of the saury-pikes, but the latter are very active and violent in their movements, and if they were rushing about among a dense crowd of pilchards, the beaks could scarcely fail to pierce the latter. J. T. CUNNINGHAM.

Flinr Implements at Chelsea.

WHILE planting in the garden of this house last Wednesday, I turned up a small flint implement, an inch and a half long and an inch wide in the widest part. It is so thin and transparent, that it is possible to read large print through it. This is the second I have found, the previous one being angular and pointed. A. B. MARSHALL.

Belle Vue House, 92 Cheyne Walk, S.W., April 18.

The Misuse of Coal.

PROF. PERRY, in his manifesto in NATURE of March 20 (with which, subject to a reservation in respect of the following extract, I venture reapectfully to agree) says (p. 464):—

"For the heating of buildings Lord Kelvin pointed out long ago that the very law of thermodynamics which makes a heat-power engine inefficient makes it possible to obtain from one unit of energy the effect of 50 or 100 units by direct heating. . . Discover the energy engine and you multiply your power to heat buildings from coal, seventy and seven times."

May I ask if Prof. Perry adheres to the foregoing statement, and if so, ask him through you to kindly add some elucidation of it? SUBSCRIBER.

Derby, April 15.

"SUBSCRIBER" may be referred to § 196 of my book on "Steam," where I explain Lord Kelvin's suggestion and give a numerical example. I assume no better utilisation of coal than one gets from a gas engine using Dowson gas and practical conditions, and yet here are the two answers for one pound of coal:—

(1) By direct heating, all the heat of the coal being given to the air (it is unusual to give nearly so much), the air gets 8300 units (Centigrade pound) of heat.

(2) By using a gas engine and reversed heat engine, 37,620 units of heat are given to the air. This is only four and a half times and not the seventy-and-seven of which I somewhat rhetorically spoke. But with the perfect energy engine of the future we may get nearly six times what we get from the gas engine now. Also I considered an atmosphere at 10° C., the air to be heated to 20° C. for the warming of a building. If the rise of temperature is only 5 degrees we get twice the benefit.

It looks at first sight like a creation of energy, but this is not so. The reversed heat engine (some refrigerating machines work on this principle) receives work energy 1422 (specified in heat units); this work is converted into heat 1422, and the extra heat 36,198 is merely *transferred* from air at 10° C. to air at 20° C.

What is disadvantageous in the heat engine becomes advantageous in the reversed heat engine, whether it is used for heating or refrigerating. J. P.

A Correction.

In my letter *re* "Birds attacking Butterflies and Moths," in NATURE for March 6 (p. 415), there occur the words, "I conclude, therefore, that they were last year's birds, which knew and disliked *D. limniace.*" There is some slip here, for what I meant to say was, "I conclude, therefore, that last year's bird knew and disliked *D. limniace.*" This, it will be seen, agrees with the context; I only used one Babbler last year, and offered *D. limniace* to this only. F. FINN.

Indian Museum, Calcutta, March 27.

SOME SCIENTIFIC CENTRES.

IV.—THE HEIDELBERG PHYSICAL LABORATORY.

MOST travelled Englishmen are doubtless acquainted with the ancient town of Heidelberg, so famous for the beauty of its situation and the grandeur of its ruined castle. But far fewer know the charms of the long and romantic valley of the Neckar, at the almost sensational exit of which, from the Odenwald into the level plain of the Upper Rhine, Heidelberg stands. So also it is true that while most educated people connect Heidelberg with the great names of Kirchhoff and Bunsen and their epoch-making discoveries in spectrum analysis, it is only the special students who know how large in extent and how important in result and example is the work which has steadily gone on for many years in the physical laboratory in the Friedrichsbau.

Its small beginnings in the middle of the last century are marked by the name of Kirchhoff scratched on the window of what is now the private room of the senior assistant. From this window one may look out over the Rhine plain towards busy Mannheim, as Bunsen and Kirchhoff did one night when a fire was raging there, and they were able by spectroscopic examination of the flames to ascertain that barium and strontium were present in the burning mass. But the same window also looks across the Neckar to the Heiligenberg, along the slopes of which runs the "Philosophers' Walk," the chief of the many paths among the wooded hills around the town, which the two friends were wont to traverse in their daily "constitutionals." Bunsen is known to have said that it was during such walks that his best ideas came to him. One day the thought occurred, "If we could determine the nature of the substances burning at Mannheim, why should we not do the same with regard to the sun? But people would say we must have gone mad to dream of such a thing." All the world knows now what the result was, but it must have been a great moment when Kirchhoff could say, "Bunsen, I *have* gone mad," and Bunsen, grasping what it all meant, replied, "So have I, Kirchhoff!"

Kirchhoff's four-prism spectroscope, together with other apparatus of his, is preserved in the collections of the Laboratory, and well deserves the almost reverential awe with which it was examined by a certain foreign professor, who protested that objects of such historic interest should be kept in a fire-proof safe.

Kirchhoff, who in his later years suffered much from ill health, left Heidelberg in 1875 on his appointment as professor of theoretical physics at Berlin, where, by the way, he had no official laboratory, and carried on his experimental work (*e.g.* the research on the conductivities of the metals for heat and electricity) in the laboratory of his friend von Hansemann. His successor at Heidelberg was his former pupil, Quincke, who has been professor there ever since, and is now the "doyen" of German physicists, both by length of service—for though only sixty-seven he has been a professor for more than forty years—and by the amount and variety of his scientific work. It is true that this work has not been of the kind that gets into the newspapers, but the real students will certainly value it none the less on that account, and even the beginner in science has heard of "Quincke's Interference Tube" and his standard measurements of capillary constants. English students may well take some special interest in Quincke, for his personal relations with English men of science (*e.g.* Lord Kelvin and Sir Henry Roscoe) have been particularly close; he is never tired of dwelling with admiration on the achievements of Young, Faraday and Kelvin—and in the case of Young in particular of vindicating his priority in respect of many of the ideas in light and sound often regarded as original to Fresnel and Helmholtz—and nowhere have his own researches been more highly valued than in this country, as is shown by the long list of Universities (Cambridge, Oxford, Glasgow) and learned societies (from the Royal Society downwards) which have conferred their honours upon him.

Georg Hermann Quincke was born at Frankfort a. O. in 1834 of partly Huguenot extraction. One who has seen the diagrams, with circles worthy of Giotto, which he draws on the blackboard, or had experience of his apparently intuitive knowledge of the possibilities of the most various materials and mechanical processes, might well be inclined to regard this kind of power, so valuable to the physicist, as an inheritance from some skilful Huguenot ancestor. From 1852 onwards he studied at Berlin, and then for a time at Königsberg, attracted thither (with others, such as Kirchhoff and Clebsch) by the fact that F. E. Neumann was delivering the only course of lectures on mathematical physics then to be heard in Germany. Neumann's mathematical and experimental genius had considerable influence on Quincke, and it was here that the profound interest in molecular physics which has dominated his life-work was aroused in connection with the theory of capillarity. But Neumann allowed his pupils too little scope for originality, and Quincke removed to Heidelberg, where (in 1854) Kirchhoff had just been appointed professor of physics. Under him Quincke carried out (in 1856) his first physical research, an investigation of the lines of flow of an electric current from one point to another of a metal plate. With a plate made of adjoining semicircles of copper and lead, Kirchhoff's law of the refraction of currents was confirmed, viz. that the *tangents* of the angles of incidence and refraction are in a constant ratio, though, curiously enough, this ratio was not found equal to that of the conductivities of the two metals, as the theory requires, but only about half as great. During this time—in which Matthiessen and Roscoe were among his fellow students—Quincke also worked much with Bunsen, especially in gas and mineral analysis, and, indeed, his first published paper was on the red and grey gneiss of the Erzgebirg (1856). Doubtless the association with Bunsen did something to cultivate Quincke's native faculty for the ingenious adaptation of the simplest materials, of which more hereafter.

From Heidelberg Quincke returned to Berlin, "promovierte" in 1858, became "Privat docent" in 1859, in 1860 was appointed professor at the Royal Prussian "Gewerbe Akademie" and in 1865 "ausserordentlicher" professor at the University of Berlin, posts which he held till 1872. His courses of lectures included the only one in mathematical physics then given in Berlin. But as regards original work the young professor was much hampered by the fact that he had neither stores of apparatus nor even a decent library of scientific literature at his disposal. In both respects he was much aided by his friend Wilhelmy (of invert sugar fame), who possessed a good deal of apparatus brought from Paris, and by Mitscherlich. Before this Mitscherlich had introduced him to G. Wiedemann, and a beautifully kept juvenile note-book had led to his drawing the figures for some of Wiedemann's publications. How well he was capable of such work will be clear to all who have seen his lithographed sheets of instructions for practical work in use in his present laboratory, with their admirable diagrams.

With Wilhelmy's apparatus, and much which he constructed for himself, often out of the simplest materials, he was able to exhibit many of the chief optical experiments which could at that time be seen nowhere else out of Paris, and to inspect which some of the leading men of science in Berlin, such as the mathematician Kronecker, were glad to visit him. To take but one instance of his ingenuity in devising efficient substitutes for the complicated and expensive forms of apparatus generally used, we may mention his method of constructing a Fresnel's double mirror. Two equal plates of black glass are fastened to a suitable wooden slab by means of four wax pellets, two under the corners of the adjacent edges, and one each under the centre of the opposite ends of the plates. If now a thin sheet of glass is laid over the whole and gently pressed down in the centre, the two glass plates become inclined to one another at slightly less than 180°, forming— *experto crede* —a perfect Fresnel's mirror. In this way the students in his present "Praktikum" construct this piece of apparatus for themselves as required.

Quincke's settlement in Berlin was signalised by his discovery of the "Strömungsströme," or electric currents produced by the flow of liquids past solid walls, which is the inverse phenomenon to the "elektrische Fortführung," or transport by an electric current of suspended particles through liquids in narrow channels. This he examined in an extensive research, leading to the conclusion that both phenomena were due to electrification by contact of the liquid with the solid wall or the suspended particles. The range of cases in which electrification is produced by contact of dissimilar substances was thus largely increased, and *inter alia* it was shown that a bubble of air in contact with water carries a negative charge, a result which accounts for the interesting discovery of Lenard that in the neighbourhood of Alpine waterfalls the air is invariably strongly negatively charged.

To this same period belong two extensive series of researches in optics and capillarity respectively. The optical investigations, recorded in close upon a score of lengthy papers in *Poggendorff's Annalen*, deal with the most difficult questions connected with the optical properties of metals, the researches of Cauchy, Stokes and Jamin, and the behaviour of polarised and diffracted light in general. From among the results obtained we have only space to mention the discovery of "lamellar diffraction,"[1] the proof that neither Jamin's law of polarisation by reflection nor Stokes's theory of the polarisation of diffracted light is in accord with all the facts, the considerable addition to the theory of the diffraction grating, and the startling deduction from some of the work of the fact (long afterwards confirmed by Kundt and others) that the refractive index of silver and gold for sodium light is less than 1, a result which of course means that light travels faster through these metals than in air. It is an interesting fact that these researches were originally prompted by the hope of penetrating more deeply into the secrets of the molecular constitution of matter. Many of them were carried out by the help of thin metallic films deposited on glass. But these very films did not a little to show that capillary phenomena were likely to be more fruitful in this direction. One of the most elegant of modern researches is that in which (1869) he used a wedge-shaped film of silver deposited on glass to measure the range of molecular attraction, by determining the thickness of the silver film through which the capillary action of the glass on water in contact with the plate just vanished. The result was that the radius of the sphere of action of the molecules is about 50 $\mu\mu$ (*i.e.* about one-tenth of an average light-wave). This was the first effective attack on this profoundly interesting problem; the method remains the least exceptionable yet devised, and the result has been confirmed by the later researches of Sohncke (1890),[1] though Röntgen and others, by means of more questionable methods, have found a value many times smaller.

It will be convenient to speak of the capillary researches in a general view presently, but mention must be made here of the well-known acoustic interference tube. The invention of this (1866) was due to a case communicated to him by a doctor, in which a patient, whose hearing was being tested by sounding a tuning-fork at the end of a rubber tube leading to his ear, was found to hear better when the tube was pinched. This was the first of several forms of acoustic interference apparatus devised by Quincke, which have been used by his pupils for investigations on the velocity of sound under various conditions, recently, for instance, in air at high temperatures. From this research it appears that the ratio of the specific heats for air falls from 1·40 at 0° C. to 1·34 at 1000° C.

In 1872 Quincke was appointed to the chair at Würzburg, whence he was called in 1875 to fill Kirchhoff's place at Heidelberg. His work there has been marked by a long series of electric and capillary researches, and by a great increase both in the efficiency of the laboratory and in the number of students. Among those who have studied under Quincke or worked in his laboratory may be mentioned Profs. Lenard (Kiel), Braun (Strassburg), W. König (Frankfort), Max Wolf (Heidelberg), Precht (Hannover), and Willard Gibbs and Michelson of America. The work is still hampered by want of room and by the antiquated character of the building, which compares but poorly with the "Paläste der Physik" recently erected at several of the German Universities. But men are more than buildings, and Quincke has shown astonishing ingenuity in utilising the space and means at command to accommodate the 120 students who attend his "Praktikum."

It is perhaps in association with the practical work of his laboratory that Quincke is seen at his best. He maintains a constant interest in the doings of his "Praktikanten"; no student is too dull nor any experiment too simple to enlist his personal attention. His research students find him unfailing in advice and assistance of the most helpful kind. If he is on occasion "heftig," it is only to become kinder and more helpful than ever. He gives his time ungrudgingly to his "Colloquium" and "Seminar." In the latter (held in the summer Semester) he lectures at length on some classical research, the practical work in connection with which is then carried out by the students, and the theory reproduced and results recorded in full for his approval and criticism. The Colloquium (in the winter Semester) is a small society for the discussion of current physical research. Here one learns to admire alike the patient consideration he shows the "Vortragender" (even if the latter happen to be a foreigner stumbling through his task in the most deplorable German), the independence and originality of his own outlook on current theories, and his extraordinarily wide acquaintance with both the older and the most recent literature of physics.

His lectures deal with an unusually wide range of topics, and are illustrated, not merely by a large collection of diagrams mostly drawn, and where necessary coloured, by his own hand, but also by many experiments rarely exhibited elsewhere. To quote a few instances almost at random, it is not often that one has the opportunity of seeing Cornu's hyperbolas (formed by reflection of monochromatic light from the surface of a bent glass strip), or water spread out in a capillary film on the surface of mercury, or experimental proof of the fact that super-

[1] Precht (*Wied. Ann.* lxi.) believes he has found a similar phenomenon in the case of Röntgen rays.

[1] And by the investigation of R. Weber (1901) on oil films (referred to in Prof. Rücker's recent presidential address), which was carried out in Quincke's own laboratory.

saturated water vapour only condenses in presence of suitable nuclei, or the production of double refraction by electrostatic stress (Kerr effect) in liquids, or Faraday's pretty experiments on the electrolytic action of the current from a frictional machine, or the beautifully ingenious demonstration, by manometric measurement of the pressure of an air bubble between the plates of a condenser immersed in an insulating fluid, of the pressure perpendicular to the lines of force in the electric field and its relation to the difference of potential between the plates. This last experiment was originally devised by Quincke in connection with an important research on the dielectric constant (sp. ind. cap.) of liquids, which he measured in three different ways—the ordinary "capacity" method, the measurement of the attraction between the plates in air and in the liquid (*i.e.* of the force parallel to the field), and, as just mentioned, of the pressure perpendicular thereto. The three methods yielded results which were, on the whole, in very satisfactory agreement with one another and with Clerk Maxwell's theory, *e.g.* for CS_2 2·64, 2·67, 2·74 (square of refractive index for D line 2·69).

This was only one of a long series (1880–1888) of electric and magnetic researches. These dealt, *inter alia*, with the alteration in elasticity, volume and refractive power produced by electrification ("electric expansion" and electrostatic double refraction, with the suggestion that the latter may be explained by the former). Deserving of especial mention is the discovery of the changes in level of magnetic (and diamagnetic) liquids contained in the capillary limb of a U-tube placed in the magnetic field. These changes are due to the difference of the "magnetic pressures" perpendicular to the lines of force in the liquid and the surrounding gas (compare the electric case above); they are proportional to the susceptibility of the liquid and the square of the field strength, and if the latter be independently determined, the susceptibility is deduced. By varying the gas in contact with the liquid, the susceptibility of gases may be measured. A method similar in principle is applicable to solids in the form of wires or electrolytic deposits on suitable rods. When once the susceptibility of suitable liquids (ferric and manganese chlorides are among the best) has been determined, the method can be used with great advantage to measure the strength of magnetic fields.

All this opened a wide field of research, but space forbids us to dwell on the interesting developments respecting "atomic magnetism" and other points.

Quincke is probably most widely known by his researches in capillarity, which have been of the most extensive and laborious kind. For the fundamental liquids, as we may call them, *i.e.* water and mercury, he has made great use of the methods of flat drops, and of air bubbles in the liquid, and therewith found values of the surface tension somewhat higher than those obtained by himself and others in other ways, in particular (for water) by the well-known capillary-tube method. He regards these higher values as the more probable, and concludes that the angle of contact of water and glass is not zero, as usually assumed, and therefore the water does not rise so high in capillary tubes as it would if the angle actually vanished. He has confirmed this by devising methods for measuring this angle of contact both on flat surfaces and in capillary tubes, and thus shown that for water and glass the angle may be 20° or so. He has also proved how sensitive the angle is to slight and often imperceptible changes in the condition

Georg Quincke

of the surface. For water on cleavage surfaces of mica, for instance, it varies from 0° to 30° or more, according as the surface is quite fresh or has been exposed for shorter or longer periods to the air. By this principle of the variation of the angle of contact, and consequently of the size and appearance of small drops of liquid (water, mercury) deposited on a surface different parts of which are in imperceptibly different conditions, he has explained the formation of the curious "breath figures" and of Daguerreotype photographs. Daguerre discovered these through the accident of having left some of his silver iodide plates, which he had until then been unable to make permanent, in a cupboard where some mercury had been spilt. The vapour deposited itself in different-sized droplets on the different parts of the plate and gave a picture which could be made permanent.

The very extensive series of researches Quincke has made on salt solutions lead to the general result that the

surface tension of such solutions increases with greater concentration by a term proportional to the number of equivalent weights of salt in the solution. For fused solid substances he has measured the surface tension by the methods depending on the weight of falling drops, and on the size and form of drops formed on a flat surface. Employing, then, a quantity a^2 which he calls the "specific cohesion" of the substance (defined by $a^2=2$ [surface tension]/ density), he found the remarkable result that ("to a degree of approximation closer than that which holds good for Dulong and Petit's law of atomic heats") all pure substances fall into one or other of six classes the specific cohesions of which are in the ratio of $\frac{1}{2}$ (*e.g.* phosphorus, sulphur, bromides, iodides): 1 (*e.g.* Hg, Pb, chlorides, nitrates, sugars): 2 (*e.g.* water, Ag, carbonates, sulphates): 3 (*e.g.* Zn, Fe): 4 (K): 7 (Na). It may be noted that a^2 measures the capillary attraction of a fluid sphere of unit radius on unit mass at its surface. That this quantity for various fluids is proportional to 1, 2, 3 . . . is in remarkable contrast to the fact that gravitational attraction is independent of the nature of the substances involved.

One of Quincke's most interesting and characteristic researches relates to the motions produced in drops clothed with oil films when an alkali is brought into contact with the oil, forming soap, which locally disturbs the existing surface tensions and causes a movement of the drop. Quincke sees in this the explanation of the movements of protoplasm. To quote his own words, "Ich glaube gezeigt zu haben, dass der Zellinhalt (das Protoplasma und der Zellsaft) jeder Pflanzenzelle von einer dünnen Oelhaut bekleidet ist: dass dünne Oellamellen mit festem und flüssigem Eiweiss die Plasmamasse durchziehen, und dass durch Einwirkung des alkalischen Eiweiss auf das oelsäurehaltige Oel periodisch 'Eiweiss-seife' entsteht, aufgelöst und an der Grenze von Oel und umgebender Flüssigkeit ausgebreitet wird. Diese periodische Ausbreitung der wässrigen Lösung von Eiweiss-seife gab dann die physikalische Erklärung der im Innern der Pflanzenzelle beobachteten Bewegungserscheinungen." Quincke's most recent researches relate chiefly to his favourite problems of molecular physics, but are, for the most part, still unpublished.

Reference has already been made to the Heidelberg "Praktikum," or course of practical physics, for which Quincke has devised many ingenious forms of simple and cheap apparatus, which are yet capable of giving surprisingly good quantitative results. Here one may see an optical bench which, though chiefly made of a half-metre scale and some cork, sealing wax and glass strips, yet enables the student to make all the usual measurements with mirrors and lenses, without dark room, and with an accuracy equal to that obtainable with apparatus many times larger and more expensive. Again, Quincke has invented a form of reflecting galvanometer[1] which costs some fifty shillings in all, but is sufficient for all ordinary electric measurements, not merely for learners, but also for research students. Want of space forbids us to tell of the almost innumerable devices for solving just those problems which confront so many of our science teachers in England at this moment which the Heidelberg laboratory contains. A word may be spared for two seeming trifles which are astonishingly useful. One is the lidless box used as a seat, giving three different heights, according as it is placed on its short, long or open side. A few of these can be combined with a screw clamp or two in endless ways to serve as supports for apparatus, &c. The other is a form of trestle[2] (with the two slant legs at one end replaced by one vertical one), which is very convenient as a support for pendulums and other such apparatus.

[1] This, together with Quincke's invaluable "Cathetometer Microscope," is visible on the table behind the Professor's right arm in the photograph reproduced herewith.

[2] Visible on the right of the photograph.

It is much to be hoped that Prof. Quincke may see his way to publish his laboratory notes in book form, and if he would accompany such a book with directions for carrying out what a witty Heidelberg student described as "Quincke's cork-wax-pfennig system," he would be conferring a boon on many students and more teachers. But we fear it is hardly likely that the claims on his time as teacher and investigator will allow opportunity for this to be done.

EMILIEN JEAN RENOU.

M. RENOU was born at Vendôme, March 8, 1815, and, naturally, went to the Lycée there. He entered the École Polytechnique in 1835 and later the École des Mines, where he studied under Élie de Beaumont. He subsequently visited German universities for two years, especially the lectures of Gauss at Göttingen.

From 1839–42 he was attached to the Scientific Commission of Algeria and published a "Description Géologique de l'Algérie." In 1846 he was directed to collect all the information as to Morocco which he could find, and the result was a valuable work, "Description de l'Empire du Maroc." He made a second visit to Algeria, at his own expense, to verify previous geographical determinations.

In 1850 he resolved to devote himself almost exclusively to meteorology, and he was one of the founding members of the Société Météorologique in 1853. He has published numerous papers in its *Annuaires*. He acted as its secretary for eleven years, not consecutive, and no less than four times was elected to fill the office of president.

In 1868 he was one of the members of a committee, under the presidency of Charles Ste. Claire Deville, for the organisation of the observatory of Montsouris. After the events of 1870–72, this establishment was placed under M. Marié Davy, and M. Renou had to leave.

In 1872 he was officially appointed director of a laboratory for meteorological research, an office which he held until his death. This establishment was first located at Choisy le Roi, but in a few months it was moved to Parc St. Maur, to a locality rented by M. Renou. On the official establishment of the Bureau Central de Météorologie, M. Renou's station was selected as the central station for the climate of Paris, and the instruments were moved to a plot of ground which was assigned to the Bureau, and where they now remain. M. Renou has contributed to the *Annales* of the Bureau three important papers on the climate of Paris.

M. Renou deservedly received many honours, the principal being Legion of Honour, Chevalier (1847), Officier (1884), Officier de l'Académie (1873), and Officier de l'Instruction Publique (1891).

He died on April 6 at Parc St. Maur at the age of eighty-seven; and he has bequeathed his large library to the public library of his native place, Vendôme.

R. H. S.

NOTES.

THE first of the two annual soirees of the Royal Society will be held on May 14. This is the soiree to which gentlemen only are invited.

THE meeting of the Paris Academy of Sciences on April 14 was adjourned as a sign of respect for the late Prof. A. Cornu, whose untimely death was announced by the president in the following words:—"The Academy of Sciences has suffered a great loss. Prof. Cornu died on Friday, carried away rapidly by a disease which no one could foresee would terminate so sorrowfully. Our colleague was relatively young; he entered the École Polytechnique in 1860 and was nominated a mem-

ber of our Academy in 1878, at thirty-seven years of age. Esteemed as a professor at the École Polytechnique, and contributing to the Bureau des Longitudes every year notices written in perfect language, he died while in active scientific work, leaving saddened parents and friends behind him, and universal regret in the scientific world."

LORD KELVIN has met with an enthusiastic reception in New York, and the signs of profound regard which have been shown to him are expressions of a feeling shared by the whole civilised world. On Saturday he attended the ceremony of the installation of Prof. N. B. Butler, the new president of Columbia University, and when he appeared in the procession a student cried, "Hats off to Kelvin," and all the students, men and women, lifted their college caps. In an article upon Lord Kelvin's career, the New York *Sun* says:—"There are few instruments used on land or sea that do not owe something or everything to Lord Kelvin's active brain. His presence does honour to the United States of America. We welcome him heartily." The *Tribune* says:—"It is natural that many Americans, especially those engaged in scientific pursuits, should covet an opportunity of paying their respects to our distinguished visitor." Similar sentiments appear in other journals, all testifying to Lord Kelvin's greatness of mind and character. A booklet by Mr. John Munro, just published by Mr. H. J. Drane in a series of "Bijou Biographies" (No. ix.), contains many interesting anecdotes and incidents connected with Lord Kelvin's remarkable career, and is well worth reading by those unfamiliar with his life and work.

ON Monday a brilliant reception in honour of Lord Kelvin was given at the Columbia University by the American Institute of Electrical Engineers, the National Academy of Sciences, and other leading scientific associations. Mr. Elihu Thomson, president of the Houston-Thomson Electrical Company, Prof. F. B. Crocker, Prof. Butler, president of the Columbia University, and Prof. R. S. Woodward all delivered addresses in honour of the achievements of Lord Kelvin. The New York correspondent of the *Times* reports that when Lord Kelvin rose to reply the whole audience rose and cheered him enthusiastically for several minutes. He thanked the speakers for their kindly reference to himself in connection with the laying of the Atlantic cable, "but," he added, "Americans must never forget, as the world will never forget, the name of that great American, Cyrus Field. Science has advanced greatly during the years along all lines. One of its greatest achievements has been made by Signor Marconi with wireless telegraphy. It is a great achievement to have sent a message inland from several hundred miles out at sea in this way, and it indicates that the time will come when messages will be sped right over the ocean without the use of any intervening wire. But still, submarine telegraphy will continue to serve us well, even with wireless telegraphy established as a commercial success." Lord Kelvin then proceeded to review modern scientific events, and paid a high tribute to the work done by Mr. Edison in the field of electric lighting. Mr. Edison, who was amongst those present, rose and bowed his acknowledgments to Lord Kelvin, the audience cheering him heartily. Lord Kelvin concluded his speech with a reference to the invention which made possible the transmission of power at a high voltage, and the "harnessing of Niagara Falls." He predicted that a power plant would be established at Niagara that would transmit 40,000 volts a distance of 300 miles. When Lord Kelvin resumed his seat the applause was prolonged for several minutes. After that hundreds of the distinguished audience filed past and shook hands with Lord and Lady Kelvin.

AT the Royal Institution on Thursday, May 1, Dr. A. Smith Woodward will deliver the first of three lectures on "Recent Geological Discoveries." The Friday evening discourse on May 2 will be delivered by Mr. A. E. Tutton, on "Experimental Researches on the Constitution of Crystals"; and on May 9 by Prof. J. Norman Collie, his subject being "Exploration and Climbing in the Canadian Rocky Mountains."

THE Easter vacation party at the Port Erin Biological Station has suffered by the absence abroad of Prof. Herdman and Mr. I. C. Thompson, so that it was not possible to arrange any steam dredging expeditions. Nevertheless, much good work has been done on the shore and with the tow-net, and several workers have spent a profitable vacation at the station. These include Dr. Darbishire, Miss Pratt and Miss Drey from Owens College, Messrs. Pearson and Tattersall from University College, Liverpool, and Mr. Laurie from Oxford. Mr. Cole was to have conducted a vacation class, but was unable to cross owing to a family bereavement. The new and greatly improved station is progressing rapidly and will be opened in the summer.

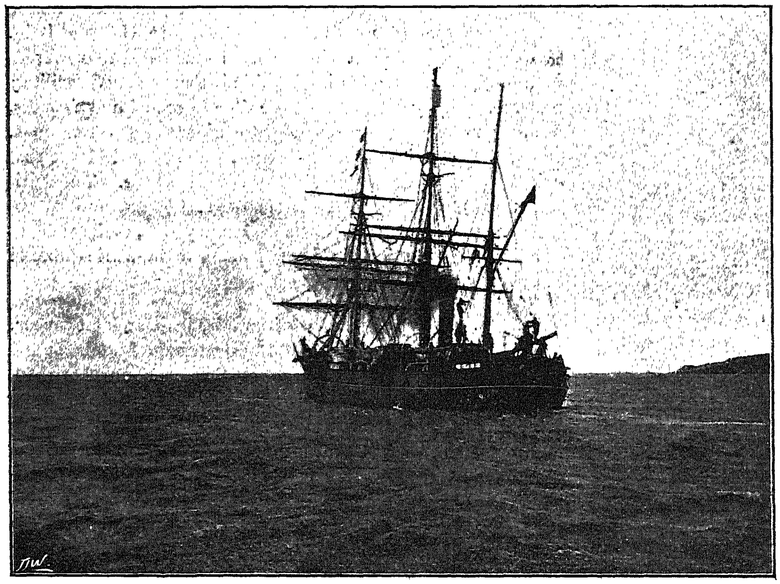
THE Decimal Association has just published a pamphlet containing strong expressions of opinion received from many Members of Parliament in favour of the compulsory adoption of the metric system of weights and measures in Great Britain. The chief reasons why a change from our present cumbrous system to a decimal system is desirable is that it would facilitate commerce, simplify calculation, save time in school and business, and bring us into closer touch with other civilised nations. Unless the system is made compulsory, there is little hope that it will be taught and used by the British people. The spirit which tolerates the present system of reckoning, and is indifferent to the advantages of the decimal system, is the same as that which regards scientific developments of industries abroad with unconcern.

THE text of the draft scheme of organised research on cancer, adopted by the Royal College of Physicians on March 24 and approved by the Royal College of Surgeons on April 10, has now been published. The scheme states that in order to promote investigations into all matters connected with, or bearing on, the causes, prevention and treatment of cancer and malignant disease, steps are to be taken, (1) to provide, extend, equip and maintain laboratories to be devoted exclusively to cancer research; (2) to encourage researches on the subject of cancer within the United Kingdom or in the British dominions beyond the seas; (3) to assist in the development of cancer-research departments in various hospitals and institutions approved by the executive committee; (4) and generally to provide means for systematic investigation in various other directions into the causes, prevention and treatment of cancer. Should the object of the fund be attained by the discovery of the cause and nature of cancer, and of an effective method of treatment, the Royal Colleges, with the consent of the trustees, are to be empowered to utilise the fund either (*a*) for equipping with the necessities for such treatment such hospitals as they may select, or (*b*) for forwarding research into other diseases. The fund is to be administered by a president, vice-presidents, trustees, honorary treasurer, general committee, and executive committee consisting of twelve members, one to be nominated by the Royal Society.

WE have received a reprint of the important paper by Col. G. E. Church, published in the March number of the *Geographical Journal*, on "Interoceanic Communication on the Western Continent." The paper first discusses possibilities of transcontinental railways in South America, but the main subject dealt with is the geographical conditions affecting the different

canal schemes in Central America. The probable traffic of a canal, when constructed, is analysed, and its chance in competition with North American railways estimated.

THE first place in the April number of the *Geographical Journal* is given to a series of three papers on the voyage southward of the *Discovery*, by Dr. H. R. Mill, Mr. George Murray, and Sir Clements Markham. Dr. Mill describes the equipment and routine work on board in meteorology and oceanography, and gives an account of his week's voyage to Madeira. Mr. Murray's paper continues the voyage from Madeira to the Cape, but it is chiefly occupied with an interesting account of a landing expedition on South Trinidad, an oceanic islet the name of which is familiar to readers of the "Cruise of the *Falcon*." Sir Clements Markham describes, from reports which have been sent home, the experiences of the *Discovery* from the time of leaving Cape Town until her final departure from Lyttelton for the Antarctic. During the eastward voyage, the *Discovery* met with exceptionally heavy weather and acquitted herself well, showing that so far as sea-going qualities are concerned her design leaves nothing to be desired, while the constructional defects developed, and partly



The *Discovery*.

made good in dock at Lyttelton, are not such as to cause apprehension of any kind. The chief features of the voyage were an excursion to lat. 63° S. in long. 140° E.—with the double object of observing the change of magnetic force along the agonic line, and of giving the ship and her crew a first taste of the ice—and a visit to Macquarie Island, where valuable collections were made. In conclusion, Sir Clements Markham describes the arrangements in progress for sending out a relief ship next June. A Norwegian whaler, the *Morning*, of Tonsberg, has already been purchased, but more funds are urgently needed for her proper equipment and dispatch. The photograph we reproduce from the *Journal* shows the *Discovery's* departure from Lyttelton.

THE United States Weather Bureau has published a discussion of the oss of life in the United States by lightning (*Bulletin* No. 30). The inquiry was begun in 1890, and has therefore extended over eleven years. The number of persons killed during 1900 was 713; of this number 291 were killed in the open, 158 in houses and 57 under trees. In the same year, 973 persons were injured; of these 327 were in houses, 243 in the open and 29 under trees. During the eleven years 1890-1900, the average number of persons killed yearly was 377. The greatest mortality by lightning, considering both unit area and density of population, is in the Ohio Valley and the Middle Atlantic States; but if density of population only be considered, it is in the Upper Missouri Valley and middle Rocky Mountain region. The great majority of storms occur in the summer season, but winter thunderstorms are not infrequent in the Gulf States and occasionally extend eastward along the Atlantic coast to Massachusetts. The *Bulletin* has been prepared by Prof. A. J. Henry, and contains some useful rules to be observed during thunderstorms and on the treatment of persons struck by lightning, even though they may be apparently dead.

MESSRS. A. GALLENKAMP AND CO., the London agents of a well-known firm of opticians of Zürich, have lately introduced to our notice two very handy and effective little instruments for obtaining the dew-point and humidity of the atmosphere without the necessity of calculating the different hygrometric values by means of the usual tables. One of the instruments, Lambrecht's polymeter, so-called from its showing several conditions, is a combination of the thermometer and hair-hygrometer, each provided with two scales, showing temperature in Fahrenheit degrees, elastic force of vapour in millimetres (or weight of vapour in grammes), the relative humidity and "number of degree," or the difference between the dew-point and the temperature of the air. For showing the temperature of the dew-point independently (if desired) a neat little instrument is used, consisting of a drum, to which a thermometer and polished disc are attached; a small quantity of ether is introduced into the drum and brought into contact with the bulb of the thermometer by forcing air into the drum by a very simple contrivance; as soon as the deposition appears on the disc, the temperature of the dew-point is indicated by the thermometer. The chief feature of these instruments is their portability and the facility with which they can be used. Both instruments will be found valuable in connection with questions of health and in certain industries which are affected by moisture; also for the prediction of weather, so far as it depends on the same cause. For the latter purpose a series of rules has been compiled by Dr. A. Troska.

IT was remarked by Laplace that when a liquid is free to rise in a capillary tube there may be several positions of equilibrium if the section is not uniform, and, moreover, that from general dynamical grounds positions of stable and unstable equilibrium follow each other alternately. A fuller investigation of this problem is now given by Signor G. Morera in a note contributed to the *Atti dei Lincei*, xi. 6. The author obtains, from mathematical considerations, a curve the intersections of which with the meridian section of the tube determine the positions of equilibrium. If in ascending the curve passes from the outside to the inside of the tube, the corresponding position of equilibrium is stable; if the contrary is the case, the position is unstable. Of course an exceptional case of what is sometimes called "stable-unstable" equilibrium occurs when Signor Morera's curve touches the meridian section of the tube. In the investigation it is assumed that the interior surface of the tube is a figure

of revolution about a vertical axis. The interest of the paper centres round the determination of the curve from which the positions of equilibrium are found.

The properties of focal lines have always presented a certain difficulty to the student of geometrical optics. In 1844, Sturm enunciated the theorem that all the rays constituting a small pencil emanating from a luminous point will, after any number of refractions, pass through two focal lines which are at right-angles to each other and to the middle ray of the pencil. Now if the refracting surfaces are surfaces of revolution on a common axis on which the luminous point is situated, the rays after any number of refractions will all intersect this axis, although it is not at right angles to the middle ray. On the contrary, if a screen be placed perpendicular to the middle ray at the point where it meets the axis of revolution, it is easy to see experimentally that the section of the pencil by this screen is approximately a figure of eight, not a straight line as Sturm's theorem would appear to indicate. We are glad to find that this point has been considered by M. H. Bouasse in a note contributed to the *Journal de Physique* for April, and his explanation should help to clear up the obscurities which exist in the conventional treatment of focal lines.

Our present state of civilisation has of necessity resulted in an annual increase in the amount of capital borrowed by man from the store of energy accumulated by our earth in bygone times, and the diversion of this capital to uses for which the world's annual income of solar energy was formerly deemed adequate. An instance of this tendency is afforded by the experiments of Dr. Selim Lemström, of Helsingfors, on the uses of electricity in stimulating the growth of cereals, vegetables and other plants. A German translation of Dr. Lemström's paper has now been issued by Dr. Otto Pringsheim. The investigation seems to have been suggested in the first instance by an attempt to connect the luxuriant growth of plants in high latitudes with the influence of electric currents associated with the Aurora Borealis. The experiments showed that for plants growing on arable land of medium quality an increase of 45 per cent. in the crops is obtainable; but the better the field is ploughed and cared for the greater will be the increase. On poor soil the effect is trifling. Certain plants, such as peas, cabbages and turnips, only lend themselves to electrical treatment after being watered. It is, however, injurious to most, if not all, plants to submit them to the influence of electricity in hot sunshine. In the introduction, Dr. Pringsheim makes some estimate of the cost of applying the method to agricultural purposes, and arrives at the conclusion that it can be made to pay. A further suggestion is that we have here an explanation of the needle-shaped leaves of coniferous plants which are well adapted to facilitate the passage of electricity, or, in common parlance, "attract electricity."

With the March number, the *Electro-Chemist and Metallurgist* starts its second volume in a new form. It is now issued as a magazine instead of, as hitherto, in the form of a weekly paper, and it must be admitted that its present style is much more suited to its contents and to the fact that it is only published bi-monthly. We wish the journal all success in its endeavour to concentrate attention on a branch of science in which this country is particularly behindhand. The present issue, amongst other interesting articles, contains an account, by Mr. J. R. Crawford, of the Crawford-Voelker electric lamp. This lamp has attracted considerable attention during the past few months, and one or two articles about it have appeared in the technical Press. There is, however, reason to believe that the problem of its commercial manufacture is not yet fully solved, but the experimental results are very promising. The filament, which is run in a vacuum, is composed of carbide of titanium, and is formed by baking in the arc a carbon filament which has been impregnated with an organic compound of titanium. An energy consumption of 2·5 watts per candle is claimed for a 200-volt lamp, which rises after 1000 hours' run to 3·35 watts per candle, the candle power falling in the same time from 16 to 13. This is a very much better result than can be obtained from a carbon lamp, and puts the Crawford-Voelker lamp almost on a level with the Nernst lamp. If the simplicity of the lamp, which requires no pre-heating, is taken into account, it will be seen that, for small units at any rate, it is likely to prove superior to Nernst's invention. In the interests of the electric light user it is to be hoped that the lamp will soon emerge from the laboratory stage of development.

The Society of Chemical Industry is gradually extending its borders, and in time, no doubt, will embrace all divisions of the English-speaking races. The New York Section, formed in 1900, is already equal to the London Section of the Society in numbers and importance, and Canadian and Australian Sections are now being formed. The first meeting of the Canadian Section was held on March 6, 1902, in Toronto, and was favoured with a paper by Mr. B. E. F. Rhodin upon the new electrolytic alkali works at Sault Sainte Marie, Ontario. These works were erected in 1900 to operate the Rhodin cell and process for production of alkali and chlorine by electrolysis, and a portion of the plant has been in use since early in 1901. The cell is of the non-diaphragm mercury type, and differs from the better-known Castner cell only in the mechanical means adopted for producing circulation of the sodium amalgam and of the mercury between the anodic and kathodic compartments of the cell. The Rhodin cell cannot be worked in this country owing to litigation, which is still pending, relating to the validity of the Rhodin patents, and the works in Canada represent the first industrial application of the cell and process. The Canadian Electro-Chemical Company are the owners of the works referred to, and a decomposing plant of 120 cells, equivalent to a daily production of 4½ tons caustic soda and 9 tons bleach, has been erected at Sault Sainte Marie. Three turbo-generators, each of 220 k.w., have been installed, and these are driven by water from the St. Mary's River, giving a head of 19 feet at the Power-house. The works are not yet in full operation, as the commercial conditions in Canada are not at present favourable for the sale of the maximum output. It is hoped by the promoters of this Company that at an early date the whole of the Canadian requirements of caustic soda and bleach, will be met by the production of the electrolytic process operated at Sault Sainte Marie.

We have received from Messrs. Friedlander, of Berlin, a copy of "Naturæ Novitates" for 1901, containing the usual valuable lists of zoological literature.

In the April number of the *Zoologist* a correspondent directs attention to the probable duration of life in the great white snail. A number of these were turned down at Blaxhall, Suffolk, in 1882 and again in 1884, and as they do not appear to have bred and some are still living, the inference is that the survivors cannot be less than eighteen years of age, while some are probably much older.

At the auction rooms of Mr. J. C. Stevens on Thursday last there was sold a portion of the collection of birds' eggs formed by the late Mr. Philip Crowley, and containing a fine series of British birds' nests with eggs, and also eggs from another property. The three lots of chief interest were a fine specimen of the Great Auk, 315*l.*; an egg of the Great Auk, 252*l.*; and a very fine specimen of the egg of the Great Æpyornis, slightly cracked, 42*l.*

A LARGE portion of part iii. and the whole of part iv. of the *Archives de Zoologie experimentale* for 1901 are occupied by an elaborate dissertation on the structure and function of the ciliated epithelium of animals—the result of experiments and investigations carried out by Monsieur P. Vignon during the last three years. The main result of the observations, according to the author, is to prove or confirm the existence of "biological coordination." In the same journal M. E. Topsent describes the sponges of the Algerian coast.

WE have received a copy of an interesting paper by Herr W. Voight, from the *Verhandlungen* of the Natural History Association of Prussian Rhineland, &c., describing the extermination of two species of annelids from the freshwaters of the district and their replacement by a third. It appears that until recently *Planaria alpina* inhabited the streams of the Hundsrückgebirge, in the north-western Thuringerwald, and *Polycelis cornuta* those of the Taunus. It is inferred that they have been inhabitants of these regions since the Glacial epoch. At first *P. alpina* alone inhabited both areas; in the Hundsrückgebirge it persisted, but in the Taunus its territory was invaded by *P. cornuta*, which became the dominant form. As the climate grew warmer, a third species, *Planaria gonocephala*, appeared in the lower past of the streams, and has since been gradually spreading upwards until it has replaced both the others over the greater part of their area, the disappearance of *P. alpina* from many streams in the one district and of *P. cornuta* from those of the other being recent events.

IT is but seldom that it falls to the lot of the same individual to reoccupy the presidential chair of a scientific (or any other) society after an interval of twenty-one years, and we have accordingly much pleasure in offering our congratulations to Prof. R. Meldola on his assumption of that position at the recent "coming-of-age" of the Essex Field Club. Indeed, the club is to be congratulated on the "staying powers" of its officials generally, the president remarking that, with a single exception, the whole of the office-bearers during its twenty-one years of existence are still among us. Probably this is absolutely unique. In his presidential address on the occasion referred to, which is fully reported in the April number of the *Essex Naturalist*, Prof. Meldola summarises the scientific work of the Society; and it is a record of which the Society may well be proud. In many respects Essex is a county offering peculiarly favourable opportunities for local scientific research. It has a large seaboard, in common with Suffolk, it contains deposits of "Red Clay," the brick-earths of Ilford and elsewhere teem with remains of Pleistocene mammals, and prehistoric and other ancient works of man abound within its limits. Moreover, in Epping Forest it possesses a tract full of interest alike to the naturalist and the antiquarian. To the workers in all the branches of local scientific research the president does full justice.

IN the *Jahrbuch der k.-k. geol. Reichsanstalt*, Band li., Heft 1 (1901), Dr. O. Abel contributes a very interesting paper on some curiously marked pebbles from the Algerian Sahara. The pebbles, as the result of exposure to desert erosion, possess a characteristic surface sculpture of ridges and furrows, which have a more or less regular radial disposition. The special interest of this character lies in its wonderfully close resemblance to the sculpture frequently exhibited by moldavite, made more particularly familiar to us through Dr. F. E. Suess's advocacy of the meteoric origin of this mineral. The sculptured pebbles dealt with in this paper are of discoid form, and radial furrows are impressed on both sides of the disc. At the periphery the furrows become more plainly marked, and tend to pass across the margin of the disc in a direction at right angles to the flattened surfaces. The author examines the possible causes of this curious sculpture, and concludes that the ordinary action of the wind, driving sand-grains against the motionless pebbles, would be quite inadequate to produce the stellate figures on opposite surfaces of the stone. He believes, however, that the natural sand-blast is, in fact, the true eroding agent, but that the pebbles were rotating when attacked by it, while raised from the ground and driven forward over the surface of the desert during repeated sand-storms. That the stellate sculpture would result from such agencies the author considers to be proved by certain experiments carried out by Dr. F. E. Suess, to which he refers. As regards the analogous sculpture of moldavite, the author suggests that it might also have been produced by the prolonged exposure of the moldavite fragments to desert conditions, an idea which is supported by the form and size of the moldavite specimens, as well as by the relative softness of this glass when compared with quartz sand. At the same time, he considers that the theory of the cosmic origin of moldavite is in no way weakened by such a conclusion. The paper is excellently illustrated.

THE University of Texas Mineral Survey, under the direction of Mr. W. B. Phillips, has issued a report on sulphur, oil and quicksilver in Trans-Pecos (*Bulletin*, No. 2, 1902). In the Cretaceous area in Texas both heavy and illuminating oils are found at no great distance from each other. The subject was dealt with in *Bulletin* No. 1; some further particulars are now given, and complete analyses of all the coals, lignites and asphalt rocks, together with tests of the fuel value of the different oils, are in preparation. Quicksilver ores, chiefly cinnabar, occur in Brewster county in hard Cretaceous limestone and in decomposed shale, the rich stringers and pockets of cinnabar being found along bedding-planes and in cracks of the limestone associated with shaly matter. Intrusions of dolerite occur near by, and with them are probably connected the disturbance of the strata and the deposition, most likely from aqueous solution, of the metallic impregnations. Important sulphur deposits are met with in El Pasco county, and it is considered that 300,000 tons are available within forty feet of the surface in the vicinity of Maverick Springs. The area is described as consisting of a white plain of gypsum with a few small hills upon it, those on the west of gypsum, and those on the east of more recent conglomerate and white dolomite. The beds of gypsum overlie Upper Carboniferous sandstones and shales and are probably of Permian age. Throughout the tract sulphur springs are common, sulphur occurs in various forms, and the soil in places contains as much as 5 per cent. of free sulphuric acid. The gypsum beds are from 300 to 500 feet thick, and sulphur occurs in small crystals embedded in white gypsum, sometimes to the extent of 25 per cent. Elsewhere the sulphur occurs as a bluish ore in a siliceous earthy gangue, yielding 70 per cent. of sulphur. The matrix is locally bituminous, and it is noted that in all localities there are signs of oil. From a careful study of the subject, Mr. E. M. Skeats is of opinion that the richer bluish ores were formed from sulphur waters at a time when they were above ground, and probably through the agency of certain algæ which are plentiful in the sulphur springs to-day. All the sulphur occurs in and with gypsum and in connection with water containing sulphuretted hydrogen. The ores in which the sulphur occurs as crystals were probably formed by the decomposition of sulphuretted hydrogen given off from the highly charged water when it entered a porous or broken stratum. It is further considered that the gypsum may have been at one time carbonate of lime, for in many places it is difficult to say where limestone ends and gypsum begins.

WHILE we have large engineering workshops all over the country supplying machinery for practical use, it is with interest we note that a journal dealing with model making on a very

practical scale is published for the benefit of young engineers and amateurs. The *Model Engineer and Amateur Electrician* forms the medium for enthusiastic students fond of engineering, and we find in its columns practical working drawings and photographs contributed and explained in a very lucid manner. Under the heading of "Queries and Replies," readers in difficulty for information get their wants adequately supplied in a subsequent issue. A good example of this is found on p. 165 (April number), where a working general arrangement of a model locomotive is given for a two and a half-inch gauge railway and drawn to a scale of half inch to a foot, in the design of which we notice water tubes placed inside and across the firebox, an idea only introduced into actual locomotive practice a few months ago. Electricity and petrol motors also form an important part within the columns of the periodical, practical types of dynamos, motors, &c., being thoroughly dealt with. A paper of this description brings within the scope of students a practical application of science to mechanical engineering, enabling them to grasp the fundamental ideas of construction and also to carry them through into a practical working form.

IN the article by Sir Michael Foster, on the Regina Margherita Observatory, in last week's NATURE (p. 569), the height of the Gnifetti hut, given as 4560 feet, should be 4560 metres; the height in feet is 14,961.

SEVEN volumes belonging to the valuable "Scientia" series have been received from the publisher, M. C. Naud, of Paris. Six of the volumes (Nos. 13–18) are in the physical section of the series, and one (No. 12) is in the biological section. Each volume may be described as a short review of knowledge of the subject with which it deals, or a statement of observations and results interpreted in the light of recent scientific thought. The titles and authors of the volumes which have just come to hand are "Cryoscopie," by the late M. F. M. Raoult; "Franges d'interférence," by Prof. J. M. de Lépinay; "La Géométrie non-euclidienne," by M. P. Barbarin; "Le Phénomène de Kerr et les Phénomènes électro-optiques," by M. E. Néculcéa; "Théorie de la Lune," by Prof. H. Andoyer; "Géométrographie, ou Art des Constructions géométriques," by M. E. Lemoine; and "L'Hérédité acquise: ses conséquences horticoles, agricoles, et medicales," by M. M. J. Constantin.

THE additions to the Zoological Society's Gardens during the past week include a Campbell's Monkey (*Cercopithecus campbelli*), a Hocheur Monkey (*Cercopithecus nictitans*) from West Africa, presented by Captain Joseph C. Verey; a Sooty Mangabey (*Cercocebus fuliginosus*) from West Africa, a Black-headed Lemur (*Lemur brunneus*), a Red-fronted Lemur (*Lemur rufifrons*) from Madagascar, two King Penguins (*Aptenodytes pennanti*), a Thick-billed Penguin (*Eudyptes pachyrhynchus*) from the Macquarie Islands, two Common Rheas (*Rhea americana*) from the Argentine Republic, a Raven (*Corvus corax*) European, two Eupatorian Parrakeets (*Palaeornis eupatria*), three Indian Rat Snakes (*Zamenis mucosa*), five Tigrine Frogs (*Rana tigrina*) from India, deposited.

OUR ASTRONOMICAL COLUMN.

ASTRONOMICAL OCCURRENCES IN MAY.

May 1. 1h. Jupiter in conjunction with moon. Jupiter 5° 59′ S.
1. 13h. 12m. to 14h. 7m. Moon occults c' Capricornii (mag. 5·2).
4. 5h. Venus in conjunction with moon. Venus 4° 19′ S.
7. Sun partially eclipsed, invisible at Greenwich.
14. 12h. 9m. Minimum of Algol (β Persei).
15. Venus. Illuminated portion of disc = 0·589, of Mars = 0·996.
17. 8h. 58m. Minimum of Algol (β Persei).

May 20. Saturn. Outer minor axis of outer ring = 14″·84.
20. 13h. 18m. Moon makes a near approach to α Libræ (mag. 3).
26. 20h. Saturn in conjunction with moon. Saturn 5° 18′ S.
28. 6h. Mercury at greatest elongation, 23° 3′ E.
28. 12h. Jupiter in conjunction with moon, Jupiter 5° 57′ S.
29. 4h. Mercury in conjunction with Neptune. Mercury 2° 52′ N.

COMET 1902 *a* (BROOKS).—The discovery of the first new comet of the present year was made by Mr. Brooks at Geneva on April 15, and the following data are supplied for the position at discovery and various subsequent epochs:—

1902.	h. m.	Place.	R.A. ° ′ ″	N.P.D. ° ′ ″	Observer
April 15	16 0	Geneva	347 2 0	62 35 0	Brooks.
,, 16	14 37	Kœnigsberg	348 55 16	63 53 25	—
,, 16	15 8·1	Copenhagen	349 3 12	63 58 39	Pechüle.
,, 16	15 30·2	Bamberg	349 6 54	64 1 1	Hartwig.
,, 16	15 45·6	Lick	350 16 56	64 47 34	Aitken.

The original announcement of discovery described the comet as being bright, with a tail. A later description by Prof. Hartwig states that the comet is about 8·5 magnitude, circular in form with a diameter of 3′. There is a central condensation and a tail somewhat less than 30′ in length.

At discovery the new comet was quite close to β Pegasi; it is now moving to the south-east rather rapidly.

NEBULÆ AND THEIR VELOCITIES IN THE LINE OF SIGHT.—Dr. J. Hartmann, of the Potsdam Observatory, gives (*Sitzungsberichte der Kön. Preuss. Akad. der Wissenschaften zu Berlin*, February 27, 1902) an interesting account of his investigation to determine the velocities in the line of sight of several gaseous nebulæ, the spectra of which he has photographed. The work was suggested to him after he had secured a very strong image of the planetary nebula G.C. 4390 with the Potsdam photographic refractor of 80 cm. in the short time of exposure of 15 minutes. In the investigation two spectroscopes were employed, that which he designates apparatus I. consisting of a flint glass prism of 60°, a collimator of 530 mm. and a camera of 720 mm. focal lengths; while apparatus III. has three flint glass prisms of 63°, a collimator of 480 mm. and a camera of 410 mm. focal lengths. The exposures of the different negatives obtained varied from 90 to 270 minutes, and the comparison spectrum photographed in each case was that of the arc spectrum of iron; the nebulæ photographed and the spectra of which were examined for movement in the line of sight were G.C. 4390, 4373, and N.G.C. 7027. Dr. Hartmann determined first of all the velocity of the nebula G.C. 4390 from the measurements of the hydrogen lines Hβ and Hγ, and from this value deduced the wave-lengths of the two chief nebula lines. All the values for the velocity as determined from the different negatives agreed well among themselves, and the deduced mean values for the wave-lengths of the two nebula lines were 5007·04 and 4959·17. While the former value is practically identical with the wave-length obtained by Prof. Keeler for the Orion nebula 5007·05 ± 0·03, the latter is somewhat greater than Keeler's value, namely 4959·02 ± 0·04. Dr. Hartmann finds that the discrepancy is easily explained, as Keeler used a spark spectrum of iron for comparison, and the two lines of iron close together at this wave-length behave differently under the two electrical conditions (arc and spark). If it be assumed that Keeler's comparison line was that at wave-length 4957·78 instead of at 4957·63—and Dr. Hartmann seems to have good reasons for making this assumption—then his own result is brought in complete accord. The paper further gives details of each of the measurements on the different photographic negatives employed, but the following table shows only the mean results obtained, giving Keeler's values for comparison:—

Nebula		Velocity Hartmann km.	Keeler km.
G.C. 4390	...	−10·5	−9·7
G.C. 4373	...	−65·8	−64·7
N.G.C. 7027	...	+4·9	+10·1

It is interesting to note that Dr. Hartmann finds slightly different values of the velocity for the middles in relation to the

edges of the nebulæ; and the curved and inclined nature of the lines, when compared with those in the comparison spectra, indicate still more clearly relative movements in the nebulæ themselves.

THE RED SPOT ON JUPITER.—In the *Astronomische Nachrichten* (Bd. 158, No. 3786), Mr. A. Stanley Williams gives a discussion of his observations of the red spot on Jupiter during 1901. The planet was badly placed owing to its great southerly declination, but during the summer months the definition was exceptionally good. Tables are given of the times occupied in the transit of the spot over the mean meridian of the disc, measures being taken from both the middle and following end of the marking. The mean rotation period thus determined is 9h. 55m. 40·92s., which is 1·38s. shorter than the value deduced from the observations of the previous year. This shortening of the length of the rotation period has also been noted by several other observers. In appearance the spot was very faint, especially at the preceding end. The following extremity, however, was fairly dark; a distinct though faint reddish tinge was generally noticeable.

Several reductions of measures of the length of the spot are given as evidence in favour of Prof. G. W. Hough's statement that the spot has not materially changed in size during the last twenty years.

THE MEANING OF THE WHITE UNDER SIDES OF ANIMALS.

PROF. E. B. POULTON has sent us the following account of a discovery of great interest to naturalists made by Mr. A. H. Thayer, and a paper in which Mr. Thayer himself describes his observations and conclusions. This paper has been specially revised for publication in NATURE, and with Prof. Poulton's introduction will be welcomed by many observers of nature.

No discovery in the wide field of animal coloration has been received with greater interest than Mr. Abbott H. Thayer's demonstration, by means of models presented to the Natural History Museums of London, Oxford and Cambridge, of the cryptic effect of the gradation of animal tints, from dark on the back to white on the belly. In spite of the intense interest aroused in students of animal life from the side of art as well as from the side of zoological science, the underlying principles have been frequently misunderstood.

Mr. Thayer has seen some of the accounts of his discovery which have appeared in this country, and he feels that the explanation offered has been inadequate and sometimes misleading. He has therefore sent for publication in NATURE a further statement, which may be regarded as an appendix to his original memoirs in *The Auk* for April and October, 1896. In this statement he makes a too generous acknowledgment of my partial discovery of the same principle (unknown to him in 1896) in two isolated cases in 1886 and 1887. I should wish, therefore, to state that I did not discover, and could never have discovered, what it required the eye of an artist to see—viz. the manner in which the total colour-effect of the cold white under side of an animal bathed in shadow and yellow earth reflections matches exactly its earth-brown back bathed in the cold blue-white of the sky. I furthermore failed to see the wide application of that part of the principle which I did discover, and not only failed to see it, but actually applied to the white under sides of animals and the white eggs of certain birds the erroneous interpretation which was then commonly received, the interpretation which Mr. Thayer disposes of so completely in the article printed below.

The following account was drawn up by the present writer for the models presented by Mr. Thayer to the Oxford University Museum. It is believed that the description of the principles concerned may be useful to students in other museums. I should add that Mr. Thayer cordially approves this description of the principles he has discovered:—

"Models to show the manner in which wild animals are commonly hidden.

"Made and presented by Abbott H. Thayer, Esq., of Scarbro, N.Y., U.S.A.

"If the two model ducks in this case be looked at from a little distance, the left-hand model will appear almost invisible, transparent and ghost-like, while the right-hand one stands out in startling contrast. The former has a colour arrangement similar to that commonly found among wild animals in nature, while the latter is entirely different.

"There are two quite distinct elements in the concealment of the left-hand model, and of such an animal as a hare or a woodcock. First there is loss of all appearance of *solidity*, secondly there is the harmony with the *colour* of the background.

"We are led to believe that any small object is *solid* and possesses a definite shape solely because of the varying depth of shade on parts of its surface more or less shielded from light. (In the case of a very large object, such as a mountain, the adjustment required when the eye focusses its near and distant parts may also aid the judgment, but this could not apply to anything so small as an animal). Thus an artist can make an object on the flat surface of his canvas appear to stand out as a solid because he paints the shadows as they would be caused by the varying degree of light on the surface of a solid. Mr. Thayer has shown for the first time that the opposite operation is quite possible, viz. that an artist can paint a solid object so as to obliterate the shadows and as a result to remove all appearance of solidity. In the case of an object illuminated, as animals are in nature, by the direct and reflected light of the sky, this is achieved by colouring the object darkest on the top where the light is strongest, gradually less dark on the sides where the light progressively lessens, and white underneath where the light is least, the darkening of the colour corresponding exactly to the strengthening of the illumination. This will be seen at once by turning the handle at the side of the case. The right-hand model is, on the other hand, of uniform colour, and appears far darker on the sides than the back, and darker still, almost dead black, underneath.

"In fact the model which is the same shade of colour all over appears to be a different shade everywhere because of the difference in illumination; while the model which is of a different shade at every level appears to be the same shade all over because the differences of shade exactly counterbalance the differences of illumination.

"Animals in nature are commonly graded in colour like the left-hand model; and Mr. Thayer's discovery of this great and yet simple principle was made because he, as an artist, recognised the ghost-like appearance of wild animals and then set to work to analyse its cause.

"But the obliteration of solidity would not effectually conceal if the *colour* did not harmonise with the environment. The back of the model, and of animals generally, is of the same tint as the brown of the earth bathed in the cold blue-white light of the sky; the under side of the model and the belly of animals is of a cold blue-white bathed in shadow and yellow earth reflections. These two mixtures produce colour effects which are similar to each other and to the mixtures of intermediate components on the sides.

"Hence with *solidity* eliminated and with *colour harmony* between environment and object, the latter appears to be but a part of the former. It is thus possible to explain the concealment of the left-hand model, or of such an animal as the hare crouching motionless on bare earth, or the numerous sand-coloured quadrupeds, birds and reptiles of the desert; but upon the surface of most animals markings are added which suggest the details of a more varied environment, such as that presented by masses of brown leaves, twigs, reeds, grasses, lichen, &c. It is obvious that in an environment full of varied detail a colouring producing a uniform effect would not conceal; hence the markings on the woodcock, ptarmigan, &c. In such cases the animal itself appears to become part of the background while its markings are seen as the details.

"Mr. Thayer has also gained further proof of the accuracy of his interpretation by painting out the gradation of colour on the sides and belly of a stuffed bird, thus extending the colour of the back over all parts of the surface. Although a living bird with its natural colouring would be almost invisible in nature, the painted specimen became extremely conspicuous when placed in the natural attitude and amid natural surroundings.

"It is not too much to assert that the broad fact of the colour gradation on the sides of animals passing into white underneath has now for the first time received its interpretation. "EDWARD B. POULTON.

"Oxford, January 22, 1902."

THE LAW WHICH UNDERLIES PROTECTIVE COLORATION.

I desire at the outset to point out that my demonstration of the principle of Protective Coloration is not the demonstration of a *theory*, but of an indisputable fact, namely, that if an object be coloured so that its tones constitute a gradation of shading and of colouring counter to the gradation of shading and of colouring which light thrown upon it would produce, such object will appear perfectly flat, retaining its length and breadth, but having lost its appearance of thickness, and when seen against a background of colour and pattern similar to its own will be essentially indistinguishable at a short distance. All persons who have seen the models which illustrate this fact know that they prove it.

Now, if this stands proved, *the fact that a vast majority of the whole Animal Kingdom wear this gradation, developed to an exquisitely minute degree, and are famous for being hard to see in their homes speaks for itself.* It is plain that their colour-gradation can no more escape effacing their look of solidity than the Law of Gravitation can escape drawing a projectile to the earth.

This is so obvious that one hears on all sides expressions of wonder that it was so long unnoticed. I may add that all persons of trained sight, such as artists, perceive it everywhere among wild creatures. Other people supplement their undeveloped sight sense by their other senses, and if they *know* the animal is solid think he *looks* solid. But the time will come when even at zoological gardens, where animals are more or less abnormally environed, people will find a new charm in recognising everywhere this wonderful adjustment of their colouring, and in perceiving its effect.

Let anyone look at a ball, or egg-shaped object, placed anywhere out of doors, and when he has recognised its shading from its light side to its dark, try to so colour it, where it stands, as to obliterate both its shading and its colour-gradation. (The sky-lit side is commonly the bluer). If he succeed, he will find that Nature has swiftly guided him through the same process which has taken her so long on the coats of animals, and that he has given the object the counter-gradation I speak of, and it will have dawned on him that so long as light makes its *one* gradation on objects, there is only the *one* way to neutralise it. In short, I simply prove that this arrangement of animals' colours is what so marvellously effaces them, and leave it to others to discuss the question whether concealment be a benefit to an animal and whether the fact that it is a benefit be the cause of his being concealed.

All who believe in Natural Selection will, of course, feel that this colour law is its work, and since it is so almost universally in use, and accounts, apparently, so almost exhaustively, for all the attributes of graded animal colouring, I believe it will ultimately be recognised as the most wonderful form of Darwin's great Law.

It stands alone in the startling attribute of being the only known or so far conceivable device for making objects in *full light not appear to exist.* This is a distinct plane above even the great beauty of Protective Resemblance, where the deception is of a more material nature, one thing passing itself off for another *thing.* The beautiful sequence of this law, which causes the grading colours to become a picture of the background, I will not force upon those who have not yet digested the first part.

It might be worth pointing out that the old theory that the bellies of fish and tree birds were white to match the sky when seen from below finds itself essentially done away with, since the fishes' or birds' opacity causes even their white to look very dark against an ordinary sky, while this same white proves to work so brilliant a success for the purpose I have shown. All people know the ghostly transparent look of fish in the water. The white bellies of birds do help them to match the *translucent foliage overhead* when seen from below, but the cold sky-holes between the leaves are far too bright. Natural Selection has, of course, surely modified all attributes to suit, not merely main ends, but all minor ones, according to the rank of their importance.

Since publishing my papers in *The Auk* for April and October, 1896, I find that Prof. Poulton perceived years before their appearance the power of a countergrading of light to make the round surface of a pupa appear flat, and in another case the power of light colour in a depression to make the concavity disappear. In both of these cases he perceived the very *Law of Light and Shade* on which the Fact of Protective Coloration rests, and recognised the Fact itself in these instances. In his "Notes in 1886 upon Lepidopterous Larvæ, &c.," read April 6, 1887, he says (*Trans.* Ent. Soc. Lond., 1887, p. 294), "Although the cleft [between the posterior part of the body of the larva of *Rumia crataegata* and the branch] is largely filled up, . . . a considerable furrow remains, but this is not apparent because of the light colour of the fleshy processes, which prevent the attention from being directed to the shadow which would otherwise indicate the position of the groove. The processes, therefore, attain the object of softening the contact between the larva and its food-plant in a two-fold manner, by partially filling up the cleft and by neutralising the shadow in the groove which remains. I have also noticed the processes in the larva of *A. betularia*, and I believe that they are of very general occurrence in *Geometrae.*"

His other case is to be found in his "Notes in 1887 upon Lepidopterous Larvæ, &c.," read October 3, 1888. He says (*Trans.* Ent. Soc. Lond., pp. 595–6), "The most extraordinary thing about this resemblance [of the pupa of *Apatura iris* to a sallow-leaf] was the leaf-like impression of *flatness* conveyed by a pupa which was in reality very far from flat. Thus the length of the pupa was 30·5 mm.; the greatest breadth (dorso-ventral diameter), 11·5 mm.; the greatest thickness (from side to side), 8·5 mm. . . . But exactly in these places, where the obvious thickness would destroy the resemblance to a leaf, the whole effect of the roundness is neutralised by the increasing lightness of these parts—a lightness which is so disposed as to just compensate for the shadow by which alone we judge of the roundness of small objects. (Much larger objects can be judged of by the change of focus, which becomes necessary as their near or distant parts are observed.) In shading the drawing of an object so as to represent roundness, the shade is made to become gradually less and less deep as the tangential planes represented come nearer and nearer to a right angle with the axis of vision. So here, the converse of shading—the whiteness neutralising the shadow which shading is intended to represent—dies off gradually as the [representation of the] mid-rib is approached.

"The whiteness is produced by the relative abundance of white dots and a fine white marking of the surface which is present everywhere, mingled with the green. The effect is, in fact, produced by a process exactly analogous to stippling.

"By this beautiful and simple method a pupa, which is 8·5 mm. from side to side in its thickest part, appears flat and offers the most remarkable resemblance to a leaf which is a small fraction of 1 mm. in thickness." ABBOTT H. THAYER.

Scarbro, New York.

REPORT OF THE SMITHSONIAN INSTITUTION.

DR. S. P. LANGLEY'S report upon the operations of the Smithsonian Institution for the year ending last June has just reached this country. Many subjects of interest are referred to in the report, but we are only able to mention a few, which will, however, be sufficient to show that the Institution is taking a foremost part in the advancement and diffusion of knowledge among men of all civilised nations.

Hodgkins Fund.—Among the many applications for grants from the Hodgkins fund, it has been found practicable to approve several which conform to the conditions of the bequest. Prof. Wallace C. Sabine, of Harvard University, has received a grant for the aid of his investigations on sound, the particular phase of the problem under investigation being the subject of loudness and interference. This research requires apparatus of special design, part of which is now complete and is satisfactory. Prof. Sabine, who had charge of the design of the new symphony hall in Boston, has for several years given much attention to the problem of architectural acoustics, or the science of sound as applied to buildings. It is expected that his complete report will be of much practical interest in connection with this subject.

Details of the progress of the research mentioned in the last report as conducted by Dr. Victor Schumann, of Leipzig, have been received. The most noteworthy points in the results so far refer, perhaps, to the relation of light and electricity and to the probable insight into the nature of the Röntgen rays to be gained in the course of this investigation.

The investigations of Dr. von Lendenfeld, of the University

of Prague, are still in progress, and it is anticipated that his final report, which is now awaited, may furnish data available for greatly improving the construction of the meteorological kites now in constant use, and thus be the means of adding materially to our knowledge of atmospheric conditions at high altitudes, the practical application of which is of such general interest and usefulness.

The interesting experiments in connection with kites and with air currents at varying altitudes, which have been prosecuted for some time at the Blue Hill Meteorological Observatory by Mr. A. Lawrence Rotch, are still in progress, an additional grant having been approved this year on behalf of Mr. Rotch. It will be remembered that the original grant mentioned was made for the purpose of securing automatic kite records at a height of more than 10,000 feet, an altitude which so lately as four years ago had never been attained. Successive grants have since been made, and the persistence and skill of Mr. Rotch and his assistants have enabled him to surpass his own extraordinary record of 14,000 feet.

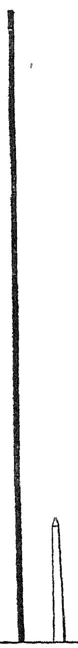


FIG. 1.—Diagram illustrating height of packing boxes, resting one upon another, used in transmitting exchanges from the United States to foreign countries during the fiscal year ending June 30, 1901, as compared with the height of the Washington Monument. Height of monument, 555 feet; height of boxes, 2,775 feet.

Dr. Carl Barus, of Brown University, has completed his research on ionised air, and his report is now in course of publication in the Smithsonian Contributions to Knowledge. This research on atmospheric conditions, in investigating the production of nuclei, determining their number per cubic centimetre, their velocity, their association with ionisation, the effect of the presence of the electric field, &c., proves interesting, not only in its own methods and results, but because of its agreement with the data obtained by other investigators from different experiments and theoretically different points of view.

The research of Prof. Louis Bevier, of Rutgers College, in connection with the analysis of vowel sounds, is steadily progressing. During the year detailed studies of several vowel sounds have been made with results which agree well with the conclusions arrived at through an entirely different method by von Helmholtz in his analysis of German vowels. The lower resonance detected in our vowel sounds by Dr. Bevier, and not recorded by von Helmholtz save for "*a*," will later be the subject of detailed discussion which will endeavour to establish and explain these facts.

Dr. Marey, of the French Institute, has received a grant in aid of his experiments on air currents. This research has been materially furthered by the successful application of chrono-photography, a field in which Dr. Marey's experiments have heretofore been noteworthy. By this means it has not only been possible to analyse the movements of waves and currents of liquids which are invisible to the naked eye, but even the displacements of molecules. From reports so far submitted, but as yet necessarily incomplete, it is believed that this research will aid materially in the solution of various problems connected with the mechanics of propulsion in fluids, at the same time rendering service in solving practical questions of ventilation, &c. The reader, if he has not noticed the rare experiment of successful machine flight of heavy bodies through the air, has probably had his attention called at times to the extraordinary difference between the performance of small steam vessels like yachts or tugs, where with equal power one glides through the water almost as though it offered no resistance, while another labours in rolling a formidable wave before it. The same differences occur in still more subtle form in the air. We cannot with the naked eye see separately, in either case, the currents that produce the effect, but by Dr. Marey's ingenious experiments photographic records can be obtained from which the forms which offer the least resistance can be studied.

The experiments of Prof. A. G. Webster, of Clark University, on the propagation, reflection and diffraction of sound, have achieved a result of practical value in the construction of an instrument capable of emitting an accurately measured sound. It is thus possible, in treating persons of defective hearing, to decide with exactness as to the degree of deafness in a subject, and to say if the power of hearing varies at different times. An instrument which furnishes the means of accurately determining these points should prove of value in medical treatment.

Prof. William Hallock, of Columbia University, New York, is conducting a research on the motion of a particle of air under the influence of articulate sound. General investigations allied to this subject, which are carried on in the laboratory of Columbia University, although in no way aided by the Hodgkins fund, have contributed helpfully to a knowledge of the principles underlying these experiments, and especially to certain parts of the investigation referring to the relation between the amplitude of vibration of an air particle and the amplitude of vibration of a film, or dust particle, suspended in the air. Dr. Hallock's research will be continued during the present year, when a final report is expected.

International Exchanges.—The importance of the work accomplished by the International Exchange Service is now well understood among men of science, and the benefits derived from it in the interchange of the publications of the civilised world are appreciated. The liberality of the American people in gratuitously supplying their scientific literature to appreciative students of it, wherever they may be, and the provision for its transmission at the expense of the United States Government and of the Smithsonian Institution jointly, are highly valued in the scientific world.

The term "International Exchanges" is now applied to the mutual exchange between Smithsonian correspondents everywhere of printed books on subjects of interest to the student in any branch of human knowledge.

The field covered by correspondents of the Smithsonian Institution and the contributors and recipients of its exchanges is now represented by one hundred and forty-eight countries, covering every part of the civilised world and extending to several countries where enlightenment has only commenced to manifest itself. In the latter are some of the most appreciative correspondents of the service. Outside the United States the Smithsonian correspondents now number 27,556, and including the United States there is a grand total of 35,705, an aggregate increase of 1754 during the year. The parcels received for transmission in 1900 numbered 121,060 (many of which contained several separate publications), representing an increase over the previous year of 7497 (Fig. 1).

In his last report Dr. Langley presented an account of his visit to London and Berlin during the summer of 1900 for the purpose of impressing upon the British and German Governments the desire of the Institution that they should each establish an international exchange bureau, or at least arrange for the transmission and distribution of exchanges so far as the United States is concerned. This work has been carried on between the United States and Germany and Great Britain from the beginning at the expense of the Institution, which has paid all expenses, even to the employing of a salaried agent in both countries. As yet no definite action has been taken by either Government.

Astrophysical Observatory.—It will be remembered that the observations of last year's eclipse by the Smithsonian expedition raised interesting questions as to the existence of intramercurial planets and as to the nature of the coronal radiations. So far did the interest in these problems extend that it was thought worth while to send an expedition from the Astrophysical Observatory to Sumatra to observe the total eclipse of May 18, 1901, and to repeat and extend the bolometric observations on the coronal radiation and the photographic observations for possible intramercurial planets. Solok, Sumatra, was the point selected for the observations. But, unfortunately, at the time of the eclipse the whole sky, excepting a perfectly clear belt around the horizon, was overcast with a sort of checkerwork of clouds, so thick that the corona could barely be distinguished. During the latter part of totality the very position of the sun was doubtful. Merely to have something to show to prove that the expedition had observed an eclipse, the programme for the intramercurial-planet apparatus was carried through, and the plates were developed. Those exposed in the first half of totality showed the corona faintly, extending out possibly a quarter or half a diameter, and showed the planets Mercury

and Venus. Nothing else could be distinguished, not even the first-magnitude star Aldebaran. The plates exposed during the last half showed even less, as the clouds were then thicker.

The accompanying illustration (Fig. 2) shows the instrument used to obtain the photographs. If the weather had been fine it would have been possible to have obtained photographs which

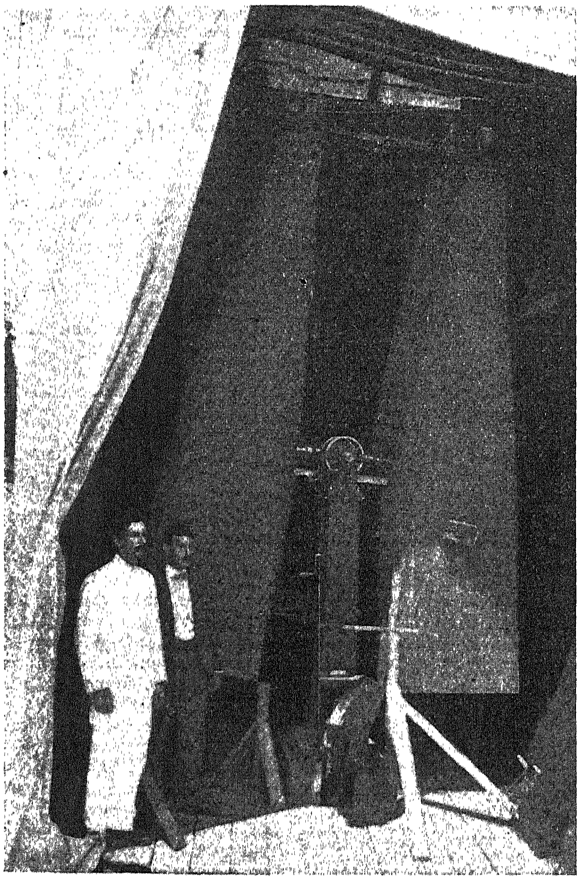


FIG. 2.—The Intra-Mercurial Planet Apparatus of the Smithsonian Institution.

would have decided whether the impressions of the supposed small planets within the orbit of Mercury, which appear upon the photographs of the previous eclipse, represent real bodies or not.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

A FEW particulars of the late Mr. Robert Irvine's bequest for the chair of bacteriology in Edinburgh University are given in the *Lancet*. Certain shares in the Christmas Island Phosphate Co., Ltd., are to form a separate trust to be invested until the property accumulates to the value of 25,000*l*. or 30,000*l*., when the trustees are to pay the sum over to the Association for the better Endowment of the University of Edinburgh, or to such authorities in connection with the University of Edinburgh as the trustees shall deem expedient, for the purpose of founding a professorship of bacteriology in the University and the equipment of a class-room and laboratory for the teaching of the same, and for conducting original investigation in that subject.

FOLLOWING the example of the London Technical Education Board, the Central Welsh Board has arranged for a conference of science teachers, to be held on Thursday, May 15, at the County Buildings, Festiniog. At the morning meeting, papers will be read by Mr. J. Griffith, on "The Teaching of Science as a Preparation for Industrial Life," and Miss Holmer, on "The Value of Biological Teaching for Girls." At the afternoon meeting, papers will be read by Dr. J. J. Findlay, on "The Correlation of the Teaching of Science and Mathematics in Lower Forms," and Mr. W. Saunders, on "Nature Study as an Introduction to Science Teaching." It is hoped that the conference will assist the development of science teaching in Welsh intermediate and technical schools.

AT the Glasgow meeting of the British Association last year, a committee was appointed in connection with the section of Educational Science to consider the conditions of health essential to the carrying on of the work of instruction in schools. The committee is collecting information and tabulating records with reference to original observations on the periods of day appropriate for different studies, the length of lesson, and the periods of study suitable for children of different ages; anthropometrical and physiological observation forms in use in various schools, with a view to prepare a typical form for general use; anthropometrical and physiological observations recorded in different schools for a series of years on the same children; investigations into the causes of defective eyesight in school children and a definition of the conditions necessary for preserving the sight, and the practical knowledge of hygiene possessed by school teachers. Cooperation in obtaining information on these points is invited. Any facts or references relating to the subjects under consideration should be sent to the chairman, Prof. C. S. Sherrington, F.R.S., or to the secretary, Mr. E. White Wallis, 72 Margaret Street, W.

A NOTABLE event, marking the progress made by agricultural education in the States, will take place on July 7, when the first classes of the Graduate School of Agriculture assemble in the Townshend Hall of the Ohio State University. The Graduate School will provide advanced instruction in agricultural science for teachers and investigators. It meets under the auspices of the Ohio State University (where the movement originated), the Department of Agriculture, and the Association of American Agricultural Colleges and Experiment Stations. The session will last for four weeks, and parallel courses of instruction in animal husbandry, dairying, the culture of field crops and other subjects will be given by a special staff of thirty professors and lecturers, including many of the best-known teachers at the American agricultural colleges. The class-rooms, laboratories and apparatus of the Agricultural College of the Ohio State University will be placed at the disposal of this staff. Typical animals will be provided for demonstration purposes, and lectures will be illustrated by specially prepared specimens and diagrams. Admission to the school is limited to graduates, or to persons specially recommended by college authorities. The fee for instruction is six dollars, and the entire cost of the course, apart from travelling expenses, need not exceed thirty dollars.

SCIENTIFIC SERIALS.

American Journal of Science, April.—On the use of the stereographic projection for geographical maps and sailing charts, by S. L. Penfield. In continuation of previous papers on the same subject, the various modes of stereographic projection are described with photographic illustrations from models, with remarks on the use of the stereographic protractor for measuring distances along great circles, of measuring spherical angles at a given point, together with various applications in navigation.—On the hind limb of Protostega, by S. W. Williston. A description of a hind limb of what is probably *P. gigas*, found in the Kansas chalk two years ago. The specimen had for the most part been washed from its matrix, and the original relations of the bones lost. It is characterised by the femur being much more slender than the specimen described by Case.—The physical effects of contact metamorphism, by Joseph Barrel. Although much has been developed in past years concerning the physical, chemical and mineralogical effects of the metamorphism produced in sedimentary beds by the contact of igneous masses, but little has been said concerning the wholesale liberation of gases from the sediments so affected. The shrinkages of volume, the formation of vein fissures, impregnation deposits, and new intrusion

of igneous matter and other phenomena due to this cause are considered in the present paper.—An expedition to the Maldives, by A. Agassiz. The most important result of the expedition was the contribution to our knowledge of atoll formation. The present definition of atolls appears to be unjustifiable, as there is every possible gradation between a curved open crescent-shaped bank of greater or less size and an absolutely closed ring of land surrounding a lagoon without direct communication with the sea.—The flower-like distortion of the coronas due to graded cloudy condensation, by C. Barus.—Varying degrees of actinism of the X-rays, by J. O. Heinze, jun. It was found that the rays which are the most active in producing fluorescence are not those which act most vigorously in the photographic plate, and hence that the maximum effect on a platinocyanide screen does not coincide with the greatest photographic effect.

Bulletin of the American Mathematical Society, March.—The application of the fundamental laws of algebra to the multiplication of infinite series, by Prof. F. Cajori. Following up his previous work (see *Transactions* of the Society, vol. ii. pp. 25–36, and *Science*, vol. xiv., September 13, 1901) and also Pringsheim's (also in vol. ii. of the *Transactions*, pp. 404–412), Prof. Cajori here establishes a class of series with real terms which possesses the property of his former paper, but which seems to be distinct from the class given by Pringsheim. He then considers the validity of the fundamental laws in the multiplication of these infinite series, and next he points out another method for obtaining divergent series whose product is absolutely convergent. Lastly he generalises a theorem of Abel on the multiplication of series.—Dr. Fite gives a notelet concerning the class of a group of order p^m that contains an operator of order p^{m-2} or p^{m-3}, p being a prime.—Dr. Epsteen contributes a proof that the group of an irreducible linear differential equation is transitive.—Another short note follows by Dr. Eisenhart, on lines of length zero on surfaces.—Dr. Kasner, writing on some properties of potential surfaces, extends some of the results of a previous paper (*Bulletin*, vol. vii. pp. 392–9) to the surfaces expressed in rectangular coordinates by an equation $\phi(x, y, z)=0$, where ϕ is a rational integral solution of the potential equation $\Delta\phi \equiv \frac{\delta^2\phi}{\delta x^2}+\frac{\delta^2\phi}{\delta y^2}+\frac{\delta^2\phi}{\delta z^2}=0$. The last four notes were read before the Society and have numerous useful references.—Prof. Osgood gives an extended review of Prof. G. A. Gibson's "Elementary Treatise on the Calculus," in which he remarks that though many teachers may not see their way to use it as a text-book during the early part of the course, yet the book can be commended for collateral reading from the very beginning, and that teachers will have to consider whether it may not be taken as the chief text-book in the second course.—Further short notices follow of Cahen's "Éléments de la Théorie des Nombres" and of R. Dedekind's "Essays on the Theory of Numbers" (Beman's translation) by Prof. L. E. Dickson, and of the "Annuaire pour l'An 1902" by Prof. E. W. Brown.

Memoirs of the St. Petersburg Society of Naturalists, Botany, vol. xxx.—On parasite fungi found in the neighbourhoods of St. Petersburg, by K. S. Ivanoff. List of 153 species, with a few remarks.—Critical review of the flora of Moscow, by A. N. Petunnikoff. Second part, continued from *Botanicheskiya Zapiski*, part xiii., 1896; full summary in German.—Botanical researches in the province of Orel, by M. D. Zalessky; summary in German. A portion of this paper is given to a detailed description of a Scotch-fir forest on a Loess soil, which is a rare case in Russia, and which the author explains in accordance with the views of Litwinow (*Bull. Soc. Nat. Moscou*, 1890, No. 3) on the survival of fir forests during the great Pleistocene glaciation.—On dormant buds, by W. Lubimenko, with twenty-nine figures; summary in German.—Exploration of the flora of Pskov in 1899–1900, by N. Puring.—The flora of the Polyesie, by Joseph Paczosski, continued. The Monocotyledones, Nos. 951 to 1291, are now given, and this most valuable work is thus concluded.

Vol. xxxi.—The whole of this volume is given to the first and the second fascicules of "Flora Caucasica Critica," by N. Kuznetsoff, N. Busch and A. Fomin. The intention of the authors is to give, in a series of monographs disposed in the same system as in A. Engler's "Pflanzenfamilien," the necessary materials for an abridged "Flora of the Caucasus." This latter would be for general use, while the present work must be a sort of preparatory work for specialists only. The successful accomplishment of this grand undertaking seems to be guaranteed—the editor, Prof. Kuznetsoff, having reasons to believe that the work will find the support of specialists. We may remark that under the heading of habitus we find for certain species extremely valuable and most interesting descriptions, which will be welcome to both the systematist and the geographer. The present volume includes the Pirolaceæ, Ericaceæ and Primulaceæ, by Kuznetsoff, and the Nymphaceæ, Ceratophyllaceæ and Ranunculaceæ, by Busch.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, November 28, 1901.—"A Comparative Study of the Spectra, Densities and Melting Points of some Groups of Elements, and of the Relation of Properties to Atomic Mass." By Hugh Ramage, B.A., A.R.C.Sc.I., St. John's College, Cambridge. Communicated by Prof. G. D. Liveing, F.R.S.

The properties of nineteen elements were studied, namely:—(1) Lithium, sodium, potassium, rubidium, cæsium; (2) copper, silver, gold; (3) magnesium, zinc, cadmium, mercury; (4) calcium, strontium, barium; (5) aluminium, gallium, indium and thallium. The flame spectra of the metals are much simpler than the arc or spark spectra; they may be regarded as the fundamental spectra of the metals. They furnish purely experimental data with which to begin an investigation of the laws which govern the distribution of lines in spectra and by which to study the relations of the physical and chemical properties of the metals to their spectra. Diagrams were drawn with the oscillation frequencies of the lines in the fundamental spectra, or the densities, or the melting points, of the metals as abscissæ, and the atomic masses, or a function of these, as ordinates. Two diagrams of spectra are reproduced in the paper. The corresponding lines in homologous spectra were joined by lines some of which are straight, but most are curved. The densities and melting points were connected in a similar way.

The following facts have been observed in the study of the diagrams:—

(1) The metals considered may be classified into groups according to the characters of their spectra. The elements in each group appear to have a similar atomic constitution.

(2) The connecting lines between the members of the chemical groups are not continuous; there are certain breaks in them. These occur between the metals sodium, magnesium and aluminium, and the metals of their respective groups with higher atomic masses. The break between the sharp series in the spectra of the aluminium group is very slight; that between the diffuse series is very marked and corresponds to marked changes in the densities and melting points of these elements.

(3) The cause of the displacement of corresponding lines in some strictly homologous spectra is intimately connected with the atomic masses. The shift of the subordinate series of potassium, rubidium and cæsium is approximately proportional to the atomic mass, whilst the shift of the principal series is very nearly proportional to the square of the atomic mass.

(4) The second diagram, drawn from the spectra and the squares of the atomic masses, shows that the lines which connect the corresponding members of homologous doublets and triplets approach one another as the atomic mass decreases and intersect on the line of zero atomic mass.

The spectra of potassium, rubidium and cæsium change regularly with the atomic mass, and it should be possible to express the series in these spectra by a formula in which the atomic mass is the only variable. There are obvious difficulties in modifying Kayser and Runge's formula in this way, but Rydberg's formula is more general and the constants are more easily calculated. Rydberg's formula and method give better results for the subordinate series than for the principal series; also for the series in the spectra of elements of low atomic mass than for those of high. The best results were obtained for the principal series of the three metals when in Rydberg's general formula

$$n=n_\infty - \frac{N_0}{(m+\mu)^2}$$

we substituted

$$n_{\infty}=35349-aW^2;\ N_0=109675$$

and

$$\mu=\{1\cdot19126+0\cdot00103W+(0\cdot04377+13W^2\times10^{-})(1-3^{1-m})\},$$

where

$$n=10^8\lambda^{-1};\ a=0\cdot2233;\ W=\text{atomic mass, and } m=1,2,3\ldots$$

This formula gives the second principal series of the three metals; the first principal series are obtained by increasing the value of μ by $182W^2\times10^{-8}$. The agreement between the observed and calculated numbers is very close. The formula, though empirical, involves only seven adjustable constants, and it represents in the table, given in the paper, thirty-two lines. It thus affords striking evidence for the fundamental identity of type of the spectra of the three metals to which it applies, and indicates that their differences depend on the atomic mass alone. This evidence is further strengthened when it is remembered that, being only an approximation to an unknown formula, it will naturally come nearer it for large values of m than for small ones. Additional evidence supporting these views is given by the above observations upon the subordinate series of these three metals. The fundamental lines in the spectra of calcium, strontium and barium are given by the formula

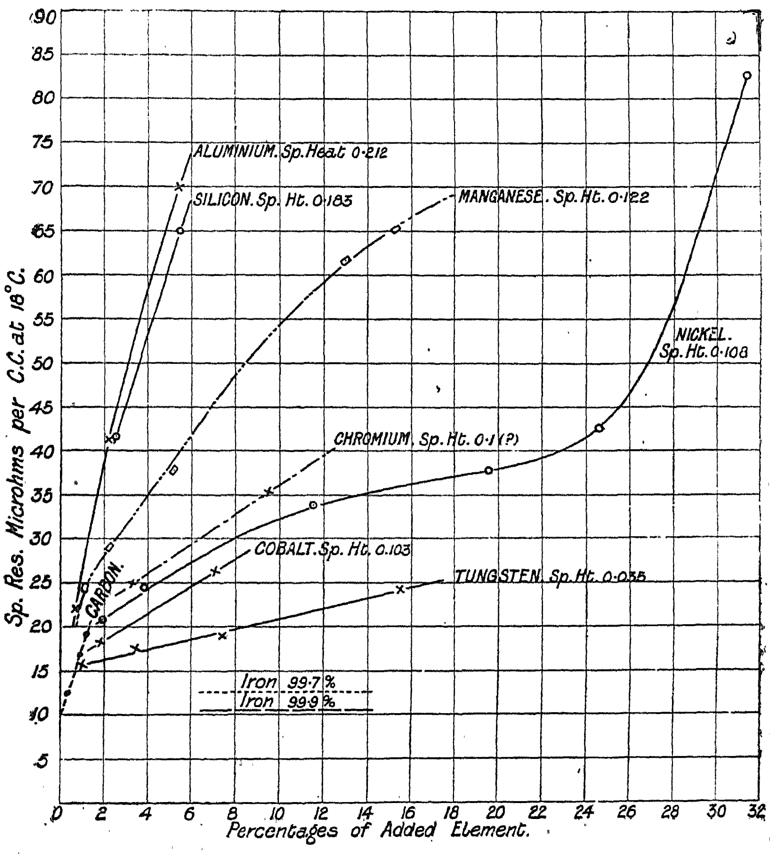
$$n=24170-0\cdot3232W^2.$$

Many points of interest are revealed by a study of these diagrams, but perhaps the greatest interest lies in the comprehensive view one gets of the order of change in the properties of the elements. The diagram of densities is easier to understand than that of melting points, and the double connections in it, from sodium to potassium and copper, from magnesium to calcium and zinc and from aluminium to scandium and gallium, are seen to be quite natural. The changes in some of the corresponding lines in the spectra agree with the changes in the densities and melting points of the elements. Other lines in the same spectra change in a manner which is independent of these.

The whole study indicates that the properties of the elements are fundamentally due to the structure of the atoms as revealed by their spectra rather than to the quantity of matter in them. It seems, for instance, inconceivable that the transition from calcium to strontium proceeded through the intermediate elements when we consider that the strontium atoms must have a similar structure to those of calcium, and that this structure is so simple that the fundamental spectrum of each of these elements consists of a single line. The anomaly, according to Mendeléeff's law, in the atomic masses of tellurium and iodine is further evidence of this. The genesis was not in the direction of tellurium to iodine, but from, or perhaps through, oxygen and fluorine respectively.

February 6.—On the increase of electrical resistivity caused by alloying iron with various elements to the specific heat of those elements. By Prof. W. F. Barrett, F.R.S.

In this paper the author draws attention to a connection which appears to exist between the electric conductivity of certain alloys of iron and the specific heats, and hence atomic masses, of the particular elements with which the iron is alloyed. In previous memoirs, the author, in conjunction with Mr. W. Brown, has determined the electric conductivity and magnetic permeability of 110 different alloys of iron prepared with great care by Mr. R. A. Hadfield, of Sheffield.[1] The results of these experiments show (1) that the conductivity of iron is diminished by alloying it with another metal even though that metal be a much better conductor than iron; (2) that this reduction of conductivity is not related to the resistivity of the added metal; on the contrary, an alloy of very high specific resistance can be produced by adding to iron an element of much lower specific resistance than the iron itself, *e.g.* the metal aluminium is upwards of three times better a conductor than iron, yet the addition of 5 per cent. of aluminium to iron makes the conductivity of the alloy five times worse than iron; (3) the greatest reduction in conductivity in a given alloy is produced by the first increments of the added element. This is shown in the accompanying diagram, where the specific resistances of some of the alloys examined (deduced from their conductivities), are plotted against the percentages of the added element: the specific resistance of iron alone being shown by the horizontal dotted lines, the upper containing 0·3 and the lower only 0·1 per cent. of carbon and other foreign bodies. The series of fairly smooth curves thus obtained for each alloy are seen to be steepest near their origin, a curious flexure being



found in the nickel steels; (4) a relationship does appear to exist between the specific heat of the added element and the resistance of the alloy it forms when united with iron. In the diagram the specific heats of the various elements are placed after their names. Thus the specific resistance of an alloy of $5\frac{1}{2}$ per cent. of aluminium with iron is seen to be 70 microhms, the same amount of silicon with iron 65 microhms, of manganese with iron 38 microhms, of nickel 27 microhms, and of tungsten 18 microhms; now the specific heats of these elements are, aluminium 0·212, silicon 0·183, manganese 0·122, nickel 0·109, and tungsten 0·035. Those elements having high specific heats, and therefore small atomic or molecular masses, produce the greatest increase in electric resistivity of the corresponding alloy with iron.

Dividing the *increase* in electric resistivity by the percentage of the added metal, we obtain the increase in the specific resistance of iron produced by 1 per cent. of the added element

[1] *Scientific Transactions of the Royal Dublin Society*, vols. vii. and viii. "Researches on the Physical Properties of the Alloys of Iron," by W. F. Barrett, W. Brown and R. A. Hadfield.

various temperatures, and by the application of the formula of Clapeyron to the data thus obtained, the heat of formation of the hydride is calculated, and compared with the value given by direct experiment. From these experiments it was also possible to give the exact conditions necessary to the preparation of metallic strontium from its amalgam.—On the combinations of alumina with chromium sesquioxide, by M. Duboin.—On the composition of the amidotariric acids, by M. Arnaud. The application of Beckmann's reaction to tariric ketoxime gave undecylamine, pimelic acid, lauric acid and amidocaproic acid, from which the formula $CH_3—(CH_2)_{10}—C\equiv C—(CH_2)_4—CO_2H$ is deduced for tariric acid.—On diacetylbenzoylethane and acetylmethylphenylfurfurane, by M. F. March.—On methoethenylbenzene, by M. M. Tiffenau.—On oxyisopropylphosphinic acid, by M. C. Marie.—The action of the organo-magnesium compounds on the β-ketonic esters, by M. V. Grignard. Acetoacetic ethyl ester reacts with magnesium methyl iodide entirely in the enolic form; its mono-alkyl derivatives appear to behave as a mixture of the enolic and ketonic forms; the product of condensation of acetoacetic ester with aldehydes react with the magnesium alkyl compounds in a manner corresponding to the formula of Classen.—On the ichthyological fauna of the basin of the Adour, by M. G. de Saint-Paul.—On the epithelio-glandular origin of the seminal cells, by M. G. Loisel. The conclusion is drawn from the experiments cited that in all vertebrates, including mammals, birds, reptiles and fishes, the seminal cells are derived from a glandular epithelium.—On the generic identity of *Zygodia axillaris* and the *Baissea*, by M. Henri Hua.—The treatment of rickets by cod liver oil containing lecithin, by M. G. Carriere. The cod liver oil used contained 0·41 per cent. of lecithin derived from eggs, and was applied in five cases, with the result that the disease was arrested and cured in from four to six months.—Researches in the variations arising in the toxic power of certain mineral and organic compounds, according to the chemical groups to which they are linked in their soluble compounds, by M. Marc Laffont.

DIARY OF SOCIETIES.

THURSDAY, APRIL 24.

ROYAL SOCIETY, at 4.30.—On Skin-currents. Part III.—The Human Skin: Dr. A. D. Waller, F.R.S.—Antarctic Origin of the Tribe Schœneæ: C. B. Clarke, F.R.S.—A New Interpretation of the Gastric Organs of *Spirula Nautilus* and the Gastropods: J. E. S. Moore and W. B. Randles.—Absolute Magnetic Observations at the Valencia Observatory (Cahirciveen, Co. Kerry), 1899, 1900 and 1901: J. E. Cullum.

ROYAL INSTITUTION, at 3.—The Oxygen Group of Elements: Prof. J. Dewar, F.R.S.

INSTITUTION OF ELECTRICAL ENGINEERS, at 8.—Problems of Electric Railways: J. Swinburne and W. R. Cooper. (Adjourned discussion).—Form of Model General Conditions, for use in connection with Contracts for Plant, Mains, and Apparatus for Electricity Works. As drafted by a Committee.

FRIDAY, APRIL 25.

ROYAL INSTITUTION, at 9.—X-Rays and Localisation: Dr. J. Mackenzie Davidson.

PHYSICAL SOCIETY, at 5.—An Exhibition of a Mechanical Break for Induction-coils: Dr. Dawson Turner.—A Temperature Indicator for use with Platinum-thermometers, in which Readings are Automatically Reduced to the Gas Scale: R. S. Whipple.—Note on the Compound Pendulum: S. A. F. White.

INSTITUTION OF CIVIL ENGINEERS, at 4.—Sir W. C. Roberts-Austen, K.C.B., F.R.S., will repeat the "James Forrest" Lecture on Metallurgy in Relation to Engineering.

MONDAY, APRIL 28.

SOCIETY OF ARTS, at 8.—Glass for Optical Instruments: Dr. R. T. Glazebrook, F.R.S.

ROYAL GEOGRAPHICAL SOCIETY, at 8.30.—Trade Routes in Eastern Persia: The Earl of Ronaldshay and Edward Penton.

INSTITUTE OF ACTUARIES, at 5.30.—Vaccination and the Act of 1898: A. F. Burridge.

TUESDAY, APRIL 29.

ANTHROPOLOGICAL INSTITUTE, at 8.30.—Stone Axes and other objects from Queensland: R. D. Darbishire.—Notes on the "Goura," the Musical Instrument of the Bushmen and Hottentots: H. Balfour.

INSTITUTION OF CIVIL ENGINEERS, at 8.—Annual General Meeting.

WEDNESDAY, APRIL 30.

SOCIETY OF ARTS, at 8.—The Timber Resources of the Australian Commonwealth: E. T. Scammell.

CHEMICAL SOCIETY, at 5.30.—(1) On the Preparation of Absolute Alcohol from Strong Spirit; (2) On the Vapour Pressures and Boiling-point of Mixed Liquids; (3) The Correction of the Boiling-points of Liquid from Observed to Normal Pressure: S. Young.—(1) On the Properties of Mixtures of the Lower Alcohols; (2) On the Properties of Mixtures of the Lower Alcohols with Benzene, and with Benzene and Water; (3) Fractional Distillation as a Method of Quantitative Analysis; (4) Vapour Pressures and Specific Volumes of Isopropyl Isobutyrate: S. Young and E. C. Fortey.—Nitrogen Bromides containing the Propionyl Group: F. D. Chattaway.

GEOLOGICAL SOCIETY, at 8.—The Origin and Associations of the Jaspers of South-eastern Anglesey: E. Greenly.—The Mineralogical Constitution of the Finer Material of the Bunter Pebble-Bed in the West of England: H. H. Thomas.—Revision of the Phyllocarida from the Chemung and Waverly Groups of Pennsylvania: Prof. C. E. Beecher.

THURSDAY, MAY 1.

ROYAL SOCIETY, at 4.30.—*Probable Papers*:—Coefficients of the Cubical Expansion of Ice, Hydrated Salts, Solid Carbonic Acid, and other Substances at Low Temperatures: Prof. J. Dewar, F.R.S.—The Conditions determinative of Chemical Change and of Electrical Conduction in Gases, and of the Phenomena of Luminosity: Prof. H. E. Armstrong, F.R.S.—On the Insulation Resistance of the Capillary Electrometer, and the Minimum Quantity of Electricity required to produce a Visible Excursion: G. J. Burch, F.R.S.

ROYAL INSTITUTION, at 3.—Recent Geological Discoveries: Dr. A. Smith Woodward, F.R.S.

LINNEAN SOCIETY, at 8.—(1) On the Mammalian Cerebellum, with special reference to the Lemurs; (2) On the Brain of the Elephant Shrew, *Macroscelides proboscideus*: Dr. Elliot Smith.—On the Early Condition of the Shoulder-Girdle in the Polyprotodont Marsupials, Dasyurus and Perameles: Dr. R. Brown.

INSTITUTION OF ELECTRICAL ENGINEERS, at 8.—Automatic Relay Translation for Long Submarine Cables: S. G. Brown.

RÖNTGEN SOCIETY, at 8.30.—The Relation between X-Rays and allied Phenomena in Light and Electricity: Ernest Payne. (*Discussion.*)

FRIDAY, MAY 2.

ROYAL INSTITUTION, at 9.—Experimental Researches on the Constitution of Crystals: A. E. Tutton, F.R.S.

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SUPPLEMENT TO "NATURE."

FIRST FRUITS OF THE CAMBRIDGE ANTHROPOLOGICAL EXPEDITION TO TORRES STRAITS.

Head-Hunters, Black, White and Brown. By Alfred C. Haddon, Sc.D., F.R.S. Pp. xxiv + 426. (London: Methuen and Co., 1901.) Price 15*s.*

UNDER this sporting title, Dr. Haddon has published a preliminary and popular account of the Cambridge Anthropological Expedition to Torres Straits and its unofficial extension to Sarawak. Expeditions for various scientific purposes have long been familiar. Expeditions for specifically anthropological purposes have been frequently organised in the United States and in Germany; but in this country such an expedition is a "new departure." Contributions to the cost of the Torres Straits Expedition came from more than one source; the chief part of the funds, however, was supplied by the University of Cambridge—hence the name. The expedition was led by Dr. Haddon, whose interest in the natives had been excited ten years before, when he visited the islands of Torres Straits on a scientific mission of a different character. He secured as colleagues Dr. W. H. R. Rivers, Dr. C. S. Myers, Mr. W. McDougall, Mr. Sidney H. Ray, Mr. C. G. Seligmann and the late Mr. Anthony Wilkin—the majority of them Cambridge men. They left London on March 10, 1898, and the last of them returned on May 31 in the following year. Nearly seven months were spent by most of them in Torres Straits, on the islands and on the mainland of New Guinea, with a short visit to the contiguous part of Australia. Upwards of four months were spent by the leader of the expedition, Mr. Ray and Mr. Seligmann at Sarawak, whither Dr. Myers and Mr. McDougall had preceded them.

The object of the expedition was not merely to investigate the physical and mental development of the islanders of Torres Straits, but to determine, if possible, their ethnological position, situated as they are geographically between the Papuans and Melanesians of New Guinea and the islands further to the eastward, on the one hand, and the Australian race on the other. The result has been to trace the population wholly to the north and east, without any recognisable admixture of the Australian element, although many of the islands, and those the largest, are within a few miles of Cape York. The amount of work done in the way of physical observations, mental tests and investigations into the civilisation of the natives will only be rendered appreciable when the official reports are complete. A very slight examination, however, of the part (by Dr. Rivers) which has already been issued will suffice to convince everyone of the extreme care with which the inquiries were conducted, and of the value of the information obtained as data for induction and as a guide for future researches.

The fact that the islanders have been under continuous European influence for a quarter of a century rendered them more docile and capable of assisting the investigations into their physical and mental qualities. But it had the inevitable disadvantage that their customs were undergoing rapid change; many interesting ceremonies and institutions had been abandoned; the old lore and many of the old superstitions were beginning to be forgotten; the shrines of the ancient worship were neglected or desecrated; and European clothing and mission churches were outward and visible signs of the new order. It is true this change was not without its compensations. Communication was made easier by the fact that nearly all the natives knew some pidgin English, as well as by their comparative familiarity with the ways of white men. But again and again things of importance that had been recoverable even ten years previously had vanished. Old men, the depositories of tradition, had died. Ceremonies which the travellers witnessed were often only make-shift and imperfect representations performed for their special behoof, and had to be supplemented by explanations, too often, doubtless, as imperfect as the representations. "It was very saddening," says Dr. Haddon, "to be continually pulled up in our researches by the oft-repeated cry of '*Too late!*'" In spite of all this, however, much survived. Amusing instances are given, showing how the old superstitions lingered in the minds of those who had renounced them and who were doing their best to lead Christian lives according to the standard of their missionary instructors.

Dr. Haddon's narrative of the expedition contains some very entertaining chapters, and some excellent stories of the natives and of the stratagems resorted to by the travellers to obtain the information they were seeking. One of the quaintest things is the account of a missionary meeting on the island of Mabuiag, which Dr. Haddon was suddenly called on to address. After the meeting was over, a war-dance was performed by some of the natives for the delectation of the scientific visitors. It was called Kwoiam's dance, after the mythical hero of the island. Men who had been singing hymns, and evincing their genuine interest in the mission by giving what were really substantial sums of money for the evangelisation of New Guinea, painted themselves with red and black and yellow ochre, adorned themselves with cocoa-nut leaves, and carried bows and arrows and (to represent decapitated human heads, such as they once had borne in grim earnest) cocoa-nuts and pawpaws. So vivid was the representation that in the course of the dance "some old women, excited by the memory of former days, could not refrain from joining also." "Imagine," exclaims the author, "a 'May meeting' in Exeter Hall closing with a war-dance!"

The narrative also contains incidentally pregnant hints for future anthropological explorers. But, on the whole, its interest is secondary to that of the ethnographical information interspersed or set forth in special chapters. Some of this is of high value, though probably not expanded as fully as it will be in the official report. The subject of totemism has during recent years occupied a large space in the discussions concerning the evolution of religion and of social institutions. Until we see the details of Dr. Haddon's discoveries it is, perhaps, premature to say that they will settle any of the questions to which it has given rise. But enough appears in the volume

before us to satisfy us of the importance of these discoveries. They point to the economic value of totemism, in which Dr Frazer has suggested its origin is to be found. The dugong-clan on Mabuiag seem to have performed rites to secure plenty of dugongs, the turtle-men to secure plenty of turtles. The office of rain-maker is said to be hereditary in a certain family, though to what clan it belonged and what position it occupied in the clan we are not yet told. The localisation of the totemic ceremonies, the use of the same word (*augŭd*) to mean the totem itself, the sacred objects used in the ceremonies, and a human ancestral (though probably mythical) hero suggest that totemism was passing into the worship of ancestors, or at least into hero-worship, "and a hero-worship that is suspiciously like the origin of a god." Not less important than the meaning and development of totemism is the delimitation of its area. Here, too, good work has been done. Although totemism was flourishing in the western islands of the Straits and bore evidence that it had been brought with the immigration from New Guinea, the travellers failed to trace it in some of the powerful stocks of British New Guinea; they ascertained that there was no true totemism in the eastern islands, and their researches in Borneo seem definitely to negative any connection between the animal-cult of the tribes in Sarawak and totemism.

Where the totem-clan does not exist, a point of great interest is the organisation of society and the conception of relationships. On this we are told nothing directly. We learn, however, that Dr. Rivers made minute inquiries into the genealogy of the Murray Islanders and some other peoples. It is to be hoped that when these are published we shall have some data for inferences, not merely as to hereditary qualities, but also as to social relations.

Interesting as the chapters relating to Torres Straits and New Guinea are, those which narrate the author's experiences in Borneo and discuss some of the superstitions practised there are in no way inferior. Balan's love-story is delightful, and the chapter on the peace-making at Baram forms an artistic conclusion to the mission. On the omen-animals Dr. Haddon is able to contribute some additional facts to our knowledge, as well as to describe the ceremonies he witnessed. The chapter on the cult of skulls, and the scenes in which he was an actor as the purchaser of skulls, are perhaps even more suggestive. We learn that the practice of taking skulls is not an ancient one among the Kayans and Kenyahs, two of the larger and more influential tribes. We are told that "some tribes believe that the persons whose heads they take will become their slaves in the next world," and that the vendetta is a common reason for the hunt of heads. But Dr. Haddon expresses no opinion on the origin and real meaning of the custom. Mr. Kruyt, a Dutch *savant*, has recently published an account of it as practised by the Toradja of Central Celebes. In that neighbouring island it would seem that the tribe referred to recognise a three-fold soul in every living being. There is, first, the breath; secondly, the personal soul; and lastly, a part of the universal soul or vital ether. It is the last which is attached to the skull and the scalp of man and other animals. To procure the skull, therefore, is to render oneself the possessor of the victim's share of the vital ether. By depositing it in the shrine of the ancestral gods, this share is offered to them. As the gods appear to be the manes of ancestors, the possession of this share of the vital ether fortifies the vital ether of the family or the clan; in other words, their portion of the universal soul is augmented. Mr. Kruyt, after examining the beliefs and customs of the Dayaks and Battaks, comes to the conclusion that their head-hunting is based upon substantially the same belief. We shall be glad to know whether Dr. Haddon has observed any facts which corroborate this theory.

The volume is adorned with numerous reproductions of photographs by the author and his colleagues, as well as by many sketches. The photographs are for the most part good, some excellent. In many cases, however, the reproduction is on too small a scale for proper exhibition of the details.

Full of interest for the general public, the volume is admirably calculated to awaken scientific curiosity and bespeak attention for the detailed results of the expedition, now in course of publication by the University Press.

E. SIDNEY HARTLAND.

THE SEA-COAST OF ENGLAND.

The Sea-coast: (1) *Destruction*, (2) *Littoral Drift*, (3) *Protection*. By W. H. Wheeler, M.Inst.C.E. Pp. xii + 361. (London: Longmans, Green and Co., 1902.) Price 10*s*. 6*d*. net.

THE sea-coast is always a fascinating object to the hydraulic engineer, for besides the varieties of its conditions, it is the place where the most vehement attacks of the orces of nature have to be encountered and provided against. The sea is an ever-present foe, the power of which when lashed into waves by gales is almost incalculable, always quick to pierce any weak point in the defences and to push forward its advantage by enlarging the breach, and sometimes producing widespread ruin before the initial damage can be repaired. Moreover, in some cases, the protection of one part of the coast leads to the weakening of an adjacent portion, and the sea, foiled in a direct attack, overcomes opposition by a sort of flank movement on an unprotected place. On some coasts the gradual advance of the sea can only be checked for a time; and the erosion of the cliffs during storms is promoted by the disintegrating action of rain and frost, the débris being scattered over the beach and eventually carried away by littoral drift. The rate of encroachment of the sea depends mainly on the exposure of the coast, the slope of the beach and foreshore, and the nature of the cliffs or shore; for on a very open sea-coast exposed to strong winds, with deep water near the shore, the erosive action of the large waves rolling in is very great, especially when breaking against cliffs composed of clay or other readily disintegrated materials. Irresistible secular changes appear to be taking place along some coasts, for a slow but steady advance of the sea may be noted in some places, and a distinct retrogression observed in other parts. The protection of land against the ravages of the sea must depend upon the value of the land and its position. Where villages and towns have been built alongside the sea-coast, large sums may be advantageously expended

in securing such valuable sites from injury, and in forming and preserving promenades in front of them; and where low-lying or reclaimed lands, extending a considerable distance inland, are protected by sea banks, it is very important that these barriers against extensive inundations should be efficiently maintained. In places, however, where long stretches of agricultural land, well above sea-level, bordering the sea-coast are subject to gradual erosion, the cost of adequately protective works would amount to more than the value of the land lost.

The author has for many years taken an interest in the changes taking place along the coasts of England, and the results of the various means adopted at different places for their protection; and his researches into records and observations of littoral drift, the action of waves and tides, sea-coast protection, and shingle-banks and sand beaches have formed the subjects of papers read at the Institution of Civil Engineers and meetings of the British Association, and articles contributed to *The Engineer* and this Journal, which have been collected together to form the present book. The subjects are dealt with under three general heads, namely, (1) "Destruction," (2) "Littoral Drift," and (3) "Protection." After a short introductory chapter, the first head is considered in a single chapter on "The Action of Shore Waves"; the second head forms the title and the subject of the following chapter; whilst the protection of the sea-coast is dealt with in three chapters, two relating to sea-walls and the third to groynes. These matters, however, occupy barely more than one-third of the book, and the remainder of the volume is taken up with an inordinately long chapter of above two hundred pages, giving details of the south, east, and west coasts of England, and a comparatively short chapter on the coasts of northern France, Belgium and Holland. These two last chapters constitute an elaborate compilation of facts concerning the sea-coasts referred to, collected from various publications, including naturally the reports and numerous data obtained by the Coast Erosion Committee of the British Association, and also the author's own observations, which should prove useful for reference; but the main interest is comprised in the earlier portion of the book, which embraces the chief object of its publication.

In the chapter on the action of shore waves, the author propounds his theory that the main agent of the littoral drift observed along our coasts is tidal action, and that storm waves are only auxiliary agents of quite minor importance; and he restates this view with greater emphasis, as an established fact, towards the close of the following chapter, on littoral drift, in these words (p. 75):—

"As already mentioned, the agent which is instrumental in building up shingle into banks and transporting it along the coast is the tide, which accomplishes this by means of the waves which are for ever breaking on the beach as the tide rises and falls. The formation and action of tidal shore wavelets has been already described in the chapter on wave-action. These wavelets, aided by the flood current, lift up and carry forward any coarse sand, loose stones, or other material with which they come in contact, and leave some portion of them stranded at the highest point on the beach to which the tide of the day reaches."

In a paper on "Littoral Drift," read at the Institution of Civil Engineers in 1896, Mr. Wheeler enunciated this theory, and in the discussion which followed, remarkable unanimity was manifested by the speakers in dissenting wholly from this view; and it may reasonably be surmised that the author hopes that acceptance of his theory, which was on that occasion denied him by the persons most conversant with the subject, may, when brought forward in the sort of authoritative form of a book, be granted him by the general public. His notion of the power of tidal action is evidently in some measure due to his assumption that the tidal wave is a wave of translation, with the entire body of water composing it in motion throughout its whole depth; and he does not realise that this would involve a continuous movement of the sea in one direction, at the rate of progression of the tidal wave, which in the Pacific Ocean, the cradle of the tides, amounts to about 1000 miles an hour, and even in the English Channel reaches about 55 miles an hour; whilst the clashing together, off the mouth of the Thames, of two of these waves of translation coming from opposite directions would be a remarkable sight. The author, moreover, in attributing littoral drift to the action of the wavelets of the flood tide along the shore, appears to ignore the reverse action of the ebb; though in referring to the effect of tidal currents on submerged sand-beds in channels, he points out that their "movement is one of oscillation and not transportation." A great number of instances might be cited of littoral currents and littoral drift which, in the absence of a tide, could not possibly be attributed to tidal action, as, for example, the littoral movement across the face of the delta of the Mississippi in the almost tideless Gulf of Mexico, the drift which occurs in various places along the shores of the Mediterranean, and the littoral current which diverts towards the south the alluvium issuing from the mouths of the Danube in the Black Sea. The author tries to strengthen his contention as to the paramount effect of the flood tide by ascribing wind waves, the power and influence of which are extended landwards by the increased depth at high water, to tidal action. Thus under the heading of "Tidal Waves" he says:—

"In the great majority of cases the waves which affect beaches, cliffs, and sea-walls are those which occur when the rise of the tide affords the necessary depth of water for their formation. . . . The maximum effect due to the tidal wave is felt at the time of high spring tides, when accompanied by heavy on-shore gales."

Further on also the following passage occurs:—

"Even when the depth of water in front of a sea-wall or cliff is only that due to the rise of tide, water from waves that break is thrown to very great heights. Thus at Hastings, where the beach at the foot of the sea-wall is dry at low water, and the depth of the water is only that due to a rise of 15 feet at high water, during a heavy gale in the winter of 1898 the broken water was thrown as high as the top of a large hotel, as shown in the frontispiece, and shingle was lifted off the beach and carried across the promenade into the bedrooms of the houses fronting the sea. At Peterhead, as already mentioned, the water due to a rise of tide on the foreshore of only 7 or 8 feet has been known to strike the wall with such force as to be thrown upwards 100 feet."

It is certain that the inhabitants of Hastings will have attributed the striking phenomenon illustrated in the book

to its true cause, the gale, aided undoubtedly by the raised water-level, due partly to the tide, and also partly to the heaping up of the sea against a lee shore by an on-shore gale; whilst the wave-stroke at Peterhead was not due, as implied above, to a tidal rise of 8 feet, but, as mentioned a few pages earlier, to the depth into which the breakwater has been carried, the great exposure of the site, and the large waves, attaining 30 feet in height and 600 feet in length during storms, which, consequently, come against the structure.

Numerous instances have been frankly quoted in the two chapters on wave action and littoral drift of the effect of waves in storms in transporting material along the coast, reference to two of which must suffice:—

"In the Solent, near Hurst Castle, a shingle bank, 2 miles long and 12 feet high, consisting principally of flints resting on a clay base, was moved forward in a north-easterly direction forty yards during a storm in 1824. . . . During a heavy gale stones weighing from 2 to 3 cwt., with large masses of seaweed growing on them, were loosened from their bed at a depth of fifteen fathoms, and thrown on to the beach."

Compared with the forces displayed by these effects, and the others given in the book produced by waves in storms, the wavelets of the flood tide sink into insignificance; and, thanks to the fairness with which these examples have been given, it may be anticipated that an unbiassed, intelligent perusal of these two chapters will lead to conclusions at variance with those of the author, and that it will be realised that waves in storms are the chief forces producing changes in coasts and littoral drift, exercising their maximum effect during high water of spring tides, and when acting in unison with the tidal currents.

From an engineering point of view, the most interesting part of the book is comprised in the three chapters on coast protection by sea-walls and groynes. Sea-walls formed of embankments with pitched slopes, or more or less upright masonry or concrete walls, serve for directly warding off the attacks of the waves in storms from the shore, cliffs, or sea-drives and promenades; whilst groynes of timber, fascines, or concrete are projected at intervals down the beach to arrest the littoral drift, and by thus gradually raising the strand prevent the sea from eroding the shore. Unfortunately groynes, by collecting the drift along one part of the beach, deprive the unprotected portion further leeward of the supply by which its losses by erosion would be naturally replenished; and, consequently, the advance of a length of foreshore produced by groynes is accompanied by a retrogression of the adjacent portion from the cutting off of the drift. A pitched slope is adopted where the shore to be protected is low and sandy, and where materials for a wall are deficient, as along the coasts of Holland and Belgium; and a wall is resorted to where cliffs line the coast, or a sea-drive is constructed considerably above the beach; and this variety in construction is due to differences in, the conditions rather than, as suggested by the author to differences of opinion amongst engineers. A simple upright wall has advantages for breakwaters over other forms where the bottom is rocky and the depth moderate; but in contrasting Dover pier, which has not been free from injury, with the breakwaters at Cherbourg, Plymouth, and Alderney, the author has fallen into a very common error of overlooking the differences of exposure and depth of water at these sites; for Dover is situated in one of the most sheltered places of the English Channel, whereas Cherbourg is much more exposed, and the breakwaters of Plymouth and Alderney are open to the Atlantic, and the latter extends into a depth of 130 feet at low water. Sea-walls, however, differ very materially from breakwaters in being built near high-water mark, and therefore upright sea-walls are subject to considerable erosion at their toe, from the recoil of the waves dashing against them, which affects even chalk and shale, so that unless the foreshore consists of firm rock, the sea-wall, which is usually curved or battered on the face, has to be founded below the limit of erosion, or more commonly is provided with an apron to protect the portion of the beach near the sea-wall from the breaking and recoiling waves. A stepped face is sometimes given to sea-walls, so as to impede the upward run of the waves and break up the recoil; but the work must be solidly built, and only a moderate width given to the steps, otherwise the reduction of the weight on the face blocks due to their projection might lead to their dislocation under the impact of the waves. The author regards a sea-wall curving on its face from the apron laid at the slope of the beach, to the vertical at the top, as the best form, and no doubt such a form leads the waves from a horizontal to a vertical course with the least practicable opposition; but at the same time, by minimising the impediments, it causes the waves to rise higher above the wall, and the upper portion of the water is driven over the promenade by the gale. In the chapter on "Examples of Sea-walls," several sections of sea-walls are given; and both this and the succeeding chapter on "Groynes" contain many interesting details of these works; and the book as a whole furnishes a considerable amount of information about the coasts of England, which must have involved much time and trouble to collect.

EVOLUTION AND ANTI-MATERIALISM.

Principles of Western Civilisation. By Benjamin Kidd. Pp. vi+518. (London: Macmillan and Co., Ltd., 1902.) Price 15*s.* net.

TO those who, some years back, read Mr. Benjamin Kidd's "Social Evolution" with great interest and learnt much from it, his new book will be a profound disappointment. Undertaking to settle all the great questions with which our civilisation is confronted, it leaves many important facts out of sight and fails to find a remedy for the main evils. The style is ponderous and difficult. In some parts very careful reading is required if the exact meaning is to be made out.

The line of argument followed is this. Evolution has upset all our old philosophies and obliged us to remodel our way of thinking. Since Darwin's time, evolution has undergone a great development in the hands of Weismann. We now see that the future is predominant over the present. The overwhelming proportion of individuals interested in the struggle for existence are yet unborn. The contending races are struggling for "an advantage, probably always far in the future, to which the individual

and the present are alike subordinated." In the struggle, "efficiency in the future" (described as "projected efficiency") "is the determining quality," and so the future controls the present.

There are two epochs of social development. In the former of the two, the existing social organisation counted for everything. In the second, "society, with all its interests in the present, is subordinated to its own future." "Projected efficiency" is the secret of success and of progress. The want of it causes stagnation. In the city States of ancient Greece and in ancient Rome, the present was omnipotent. Marcus Aurelius, noble character as he was, represented a decaying system, bounded by the present. With the spread of Christianity, the horizon enlarges and the future becomes predominant. "The visions of Christianity can never be closed within any limitations of the State or of political consciousness." Turning to politics, we find in England at the time of the Revolution a looking beyond the present to the future. But during a later period our philosophers professed creeds that left out of consideration everything that lay beyond the horizon of the present. Bentham, Ricardo, Mill, Herbert Spencer are interested only in living individuals and their relation to the State. On the other hand, Burke says that society is a partnership "between those who are living and those who are dead and those who are to be born." In Germany, progress is hampered by a frankly materialistic philosophy, the philosophy of Marx, which takes no thought of generations yet to come. Among English-speaking peoples there is a conviction that "the principles of the Democracy which our civilisation is destined to realise are incompatible with a materialistic interpretation of history." We look to the future and not to the present. Hence the marvellous progress of our race, in spite of the fact that the average Englishman is averse to liberal ideas. An age of the free-est competition is beginning, from which immeasurable results may be expected. The present astounding expansion of the English-speaking race is as nothing compared with what is to be. And this magnificent future will be due to free competition, which will not be disgraced by the oppression of the workman by the capitalist, or by the barbarism of our present commercial methods. The predominance of the future will make all this possible. The evolutionary process will be projected altogether beyond the present.

All these theories seem to have their origin in Mr. Kidd's strong anti-materialistic convictions. His formula of the future (to propose a brief name for it), which forms the central doctrine of his creed, serves to unite his anti-materialism with the theory of evolution, which, as he maintains, must now be the foundation of all philosophy. A formula that embraces evolution and transcendental anti-materialism must, of necessity, be very vague. The predominance of the future is, therefore, stated in very indefinite terms, so that it may include things which are essentially different. Thus, evolution regards the future of the race—unborn generations—as of the utmost importance. Christianity puts the future life of the individual above his present life. These two views in a mist of grand phrases are put down as the same, or at least as different aspects of the same, truth. The treatment of philosophical systems seems to involve the same confusion of thought. For evolution, Mr. Kidd says, the unborn generations are everything. Evolution, as we all know, is, largely, independent and will go on whatever our philosophy may be; and yet the views of this or that philosopher are treated as of supreme importance, as if the fate of the nation to which he belonge were involved in them.

When we come to the most interesting and best-written chapters, those in which modern trade and its methods are described, there is again much confusion in the theories which are built upon the facts. Competition, especially in America, is more free than it has ever been before. In the future, we are told, there will be still greater freedom. Yet the fierceness of competition is to be held in check by humane laws which will protect the workman from oppression. Capital, too, will not be allowed to exploit the nation for its own advantage. This is an admirable ideal. But how is it to be combined with a freedom of competition such as has never been known before? Mr. Kidd does not help us here. We are only told that to the English-speaking peoples, free as they are from materialism, everything will be possible. Here we may ask a question:—If anti-materialism is the one secret of progress, how is it that in the East, the birthplace of all the great religions, stagnation is the rule?

We feel much the want of some sound biology. Mr. Kidd adopts some of Weismann's most disputed theories, such as that of the immortality of the unicellular organisms. But other views of Weismann's which conflict with his own theories he says nothing about. Weismann holds, for instance, that as soon as the stress of natural selection is relaxed, a species begins to lose the powers that it has gained. It degenerates. Now, this era of free competition, seen at its best in the United States, is really a time of slackening natural selection. Children are cared for better than ever before, so that many of the weakly survive. The deaf are so well taught that they can make a living and marry, and so leave deaf descendants. The competition, in fact, whether between peoples or individuals, does not lead to elimination. The conditions of life have grown softer, and under such conditions there must be, if there is truth in Weismann's contention, physical degeneration, though it may be screened by the constant influx of numbers of the more vigorous members of the European peoples into the New World. On this subject Mr. Kidd does not touch. Yet the tendency to physical degeneration, more than any other phenomenon of our time, causes anxiety to those who watch the drift of our modern civilisation.

Again, as to the main idea of the book, how is it possible that efficiency in the future, "projected efficiency," can decide a struggle that has to be fought out in the present? It is true that some classes of animals, having succeeded in one period in virtue of their specialisation, have, probably because they were so highly specialised, been unable to take a new line and meet new demands made upon them in the succeeding period. But, apparently, this is not what Mr. Kidd means. His formula is made to refer to evolution as it refers to systems of philosophy or to creeds in which the supremely important future controls the present. He owns that the contending races must fight their battles

in the present, and yet in some unexplained way "projected efficiency" decides the issue. When we look facts in the face we find that our anti-materialistic philosophy is not saving us from entering upon the same ruinous course on which the French nation has already proceeded far. Our diminishing birthrate shows that there has already begun among our people that artificial limitation of fertility which must, if it continues, bring national decline with it.

We all wish that these evils should come to an end and that the English-speaking peoples should have a magnificent future before them. Towards this, no doubt, an anti-materialistic philosophy is a help. Materialism is incompatible with real greatness in an individual or a nation. So far we may go with Mr. Kidd. But we cannot allow that he has found a formula in which all our great problems—the problems of evolution, civilisation, religion—find their solution. The problems remain as they were. F. W. H.

GALLS.

British Vegetable Galls, an Introduction to their Study By E. T. Connold. Pp. xi + 312. (London: Hutchinson and Co., 1901.) Price 10*s.* 6*d.* net.

THIS beautiful book is a great disappointment. The title, the nice paper, with its broad margin and excellent print, and, above all, the majority of the one hundred and thirty full-page plates paraded, and by no means unjustly so, on the title-page, all promise so much, and yet—on looking beneath the surface we find no depth. Typical examples of the disappointments in store for the reader are furnished by Plates 14 and 15; it would be difficult to over-praise the beauty of the process-work of the former plate, and yet practically all the information the author gives is confined to a few meagre lines on pp. 58 and 60, chiefly concerned with a note as to where the specimen was found. True, more careful search shows that Plate 47 is concerned with the same subject, and somewhat more scientific hints are appended to this on p. 126; but why, in the name of all knowledge, are we not told something of the structure and development of these galls and their contents? Unless we are mistaken, or misled by synonymy, the very example here referred to is a classical one. Did not Dujardin describe the mite in the hazel-buds in 1851? and did not Miss Ormerod and Schlechtendal show that witches' brooms on the alder arise from the irritation set up by similar species? In this connection, also, excellent illustrations of the witches' brooms themselves are given on Plates 1, 16, 17 and 18, with such irritating gossip as "this very interesting tree stands just within the confines of the Park"—"Park," with a capital P!

Now, if we may be permitted to direct the attention of the author (who is the honorary general secretary to the Hastings and St. Leonard's Natural History Society) to the grand opportunity he has missed, pointing out at the same time that scientific experts rarely obtain the chance of putting forth their text illustrated in the superb style of this book, some service may be done in advocation of the cause of that most useful branch of biology —good descriptive field-work in the domain of the borderland between zoology and botany.

It is scarcely too much to say of the present book that if the text to these excellent plates had been nothing more than even a fair account of the insect and its gall, such as is given in a handbook like that of Frank, it would have been one of the most worthy and useful books on the subject—how much more so had the text risen to the level of Adler's admirable study of oak-galls! If local natural history societies would only resist the temptation to be popular, in the sense which implies being merely attractive to superficial and "smart" people, what an immense amount of valuable work might be done along the lines suggested by the present volume, which, disappointing though it is, is sufficiently good to show that the author must be capable of far better work.

We sincerely hope that in a second edition the author will give such notes concerning the structure and development of the galls, the habits of the insects producing them, and their effects on the plants infested by them, as could be obtained from such authors as we have quoted, and from the works of, for instance, Küster, Molliard and other modern investigators; such an account, added to the more extensive notes on field-work which Mr. Connold could evidently bring together—as may be judged from the present samples—should be worthy of the subject, and would be far more welcome to his fellow-lovers of nature than these pages of desert margin with their oases of meagre information, however excellent the latter may here and there be in itself. We are the more constrained to urge this because we understand that the author contemplates a separate book on oak-galls. If the illustrations are as good as these, and the text far better, we shall anxiously look for that book.

THE EVOLUTION OF LIFE.

L'Évolution de la Vie. Par le Dr. Laloy, Sous-Bibliothécaire de la Faculté de Médecine de Bordeaux. Pp. xii + 240. (Paris: Libraire C. Reinwald; Schleicher Frères, 1902.) Price fr. 2·50.

THIS volume is the third of a series being issued in France under the designation of the "Petite Encyclopédie du XX^e Siècle." The object of the work, as set forth in the preface, is the very praiseworthy one of spreading a sound knowledge of the achievements of modern science among the intelligent public in a popular way. As the author points out, the mental equipment of the man of culture of the present time consists of art, literature and *belles-lettres.* Of modern science he knows nothing and cares to know nothing. Even among scientific workers themselves the extreme specialisation necessitated by original work often prevents a general perspective of the whole subject being gained. The trees prevent the individual hewer of wood from seeing the forest as a whole. We have long recognised the need for imparting scientific "culture" to the reading and thinking public in this country, and many excellent series of popular works by our foremost men of science might be mentioned. How far the present work is likely to give French readers a sound idea of modern

evolution is very difficult for an English reviewer to judge. The author deals with the subject in a way that has been made familiar by the writings of Haeckel, and we cannot say that he sheds any new light on the various questions or that his treatment is particularly lucid. Here and there Dr. Laloy lets fall a suggestive analogy or makes a remark which shows that on many of the fundamental questions of modern biology his views are at any rate sound. If he admits of being pigeon-holed at all, we should say that as regards the origin of life he is a neo-vitalist. His suggestion that protoplasm may have arisen in the first place by the direct combination of carbon with water and the subsequent combination of the carbohydrate with nitrogen under the influence of the electric discharge (p. 28) is based upon a statement of Berthelot's—that cellulose and dextrin can "fix" nitrogen under the influence of the silent electric discharge. This view is not likely to find favour, we imagine, until we have some more substantial basis of fact to support it.

Concerning the descriptive part of the book, in which the various groups of animals and plants are dealt with from the point of view of evolution in ascending order, there is little to be said. The chief interest for the student of evolution is really concentrated in the seventh chapter, in which the author reveals his position. After putting forward the well-known arguments from rudimentary organs and embryology in favour of some doctrine of evolution being necessary, Dr. Laloy proceeds to consider the factors of evolution. He considers "la lutte pour la vie et la sélection" of Darwin to be inadequate and he accordingly assigns to natural selection a quite subordinate part in the formation of species. It is difficult, however, to find out precisely what is, according to the author, the prime factor of species formation. So far as can be gathered from the text, he appears to favour a kind of sudden and spontaneous variation of all the individuals simultaneously in the direction required to adapt them to new conditions (p. 104). He relies for this remarkable factor upon the experiments of Bonnier and the observations of De Vries, and he adds :—

"Ce serait selon moi cette variation brusque et totale, cet état de mutation, comme s'exprime De Vries, qui serait la véritable cause de la formation des espèces. La lutte pour la vie et la sélection ne seraient plus que des facteurs secondaires, qui n'entrent en jeu que pour fixer et rendre stables les variations acquises en bloc et surtout, pour supprimer les différenciations fâcheuses. Elles maintiennent les espèces dans leur caractère normal, mais ne sauraient en former de nouvelles. Ainsi, comme cause principale de l'évolution, nous retrouvons encore cette finalité du protoplasma qui lui permet de s'accommoder aux circonstances les plus diverses."

This is the key to the author's position as an evolutionist. It is not likely that many adherents to these views will be found in this country. Pure Lamarckism—however inadequate we may regard it—seems, on the whole, to have something more tangible about it than the variation "brusque et totale" of all the individuals of a species in order to meet any emergency in the conditions of life. It is remarkable that a countryman of Lamarck's should go out of his way in order to introduce a factor which receives such very slender support from the observed facts of nature.

R. M.

OUTLINES OF PHYSIOLOGY.

A Primer of Physiology. By Alec Hill, author of "An Introduction to Science," &c. Pp. x + 105. (London : J. M. Dent and Co.)

IN this tiny primer of 105 pages the author attempts to give a general sketch of the subject of physiology, treating especially of those parts which may be supposed to be of most interest to a reader who is not contemplating the profession of medicine, and has not the appliances of a laboratory at his command.

As the author truly remarks in his preface :—

"The subject is so vast that a series of primers would be needed to approach its several departments through the elements of physics, chemistry, anatomy, and the other sciences upon which they are based."

Mr. Hill does not state whether these needed primers are subsequently to appear from his pen, but should they do so there is little doubt that they will prove quite as interesting to the student of physiology as the one now under consideration.

Although the space at his disposal is so exceedingly limited, yet the author finds room to dip occasionally into the realms of medicine. Here is an example of such an application taken from p. 14 :—

"The expression to 'purify the blood' is a vestige of a long-abandoned theory of medicine. In the sense in which it is used, to imply that carbuncles, boils and pimples are due to 'bad blood,' it is absurd and misleading. It is none the less true, however, that health, as shown by muscular vigour and perfect freedom from neck-ache, pains in the limbs, and other 'gouty' symptoms depends upon the blood being fully charged with oxygen, and sufficiently free from nitrogenous waste products to keep the juices of the body in a pure state."

Then in a few cogent words the author deals with the *rationale* of massage, the effect of hot baths, and the therapy of diuretics such as "sweet spirits of nitre" or "salts of various kinds"; and all this is done in one short half page.

Terseness is naturally the characteristic of this little primer throughout, but we scarcely agree with the tacitly assumed idea of the author that by the judicious use of leaded type the necessity for wasting precious space in giving definitions can be avoided. For example, the hitherto uninstructed person in physiological matters will scarcely understand at a first glance what is meant by lymph, epithelium and protoplasm, unless some explanation, other than that mentioned above, be given him.

The book opens with a four-page account of the structure, given necessarily in hasty outline, of the mammalian body; there follow eight or nine pages on minute anatomy, in which half a page is found for a description of "caryokinesis," and then, in less than forty pages, the blood and vascular system, the neuro-muscular system, digestion, absorption, dietetics and respiration are rapidly reviewed. Rather more than half the space is thus left over for the central nervous system and special senses, and here in his own special domain the author is peculiarly at home, and his imageries and analogies are at

times perfectly delightful. Take, for example, the analogy given to illustrate the perception of sensation on p. 61:—

"An errand boy pulls a bell handle (he stimulates a sense organ); the pull is conveyed up the wire (an impulse travels to the central organ); the bell rings (a sensation is produced); the maid-servant hears the bell (the sensation is perceived); she decides that a person has pulled the bell handle (passes a sensory judgment). Perhaps she is able to infer, from the violence of the ring, that it was a telegraph boy who pulled the handle. Probably she goes to the door and opens it—this is equivalent to translating sensation into action with the acquiescence of consciousness."

There is a touch of genuine humour, perhaps unconsciously given, in the use of the word "probably" in the concluding sentence of this fine description.

Finally, it may be said that few will read Mr. Hill's little primer, with its great wealth of popular allusions and applications, without learning something new, even if they be trained physiologists, although it is somewhat doubtful whether the book is not a little too condensed for a beginner.

The illustrations, like the ext, are original, and are in every respect worthy of it. Attention may here be drawn especially to the great simplicity of the diagrams of a sphygmograph on p. 20 and of the pendulum myograph on p. 33.

B. MOORE.

A PROTEST AGAINST VITALISM.

Mechanismus und Vitalismus. By O. Bütschli. Pp. 107. (Leipzig: W. Engelmann, 1901.) Price 1*s*. 9*d*.

THE work before us is a reprint of an address delivered before the International Congress of Zoology at Berlin in 1901, amplified by the addition of a preface and of explanatory and supplementary notes, which exceed considerably in bulk the original lecture. The author takes as his theme the most fundamental problem of biology, namely, the relation of life and living things to the inorganic world. With regard to this question, biologists fall, consciously or unconsciously, into two camps—on the one hand the vitalists, who do not believe that an ultimate explanation of the phenomena of life can be given in terms of the not-living; on the other hand, the "mechanists," as they are here named, who "consider it possible, even though feasible only to the most limited extent at the present time, to comprehend vital forms and vital phenomena on the basis of complicated physico-chemical conditions" (p. 8).

Prof. Bütschli, whose researches on the structure and properties of protoplasm have brought him into the closest contact with the problem of the nature of living matter in its simplest and most elementary form, approaches the question as a partisan of the mechanistic school of thought, and seeks to vindicate this position against the recent revival of vitalism which has been so prominent of late years, especially amongst physiologists. He commences with a brief exposition of his philosophical standpoint, and expresses himself "of the opinion that sensations (Empfindungen) accompany the processes (Vorgänge) of the entire world, but that consciousness, or conscious sensation, on the other hand, has come about through the building up of the nervous system, and consequently of memory, which is the foundation and cornerstone of the conscious object, or of the Ego" (p. 6 Memory is not to be regarded as a property of the livir substance as such, but as possible only with a complicat nervous apparatus (p. 52). The author proceeds next define the mechanistic position and especially to d tinguish "Mechanismus" from Materialism, with whi it has been confounded by Bunge and other vitalis "The mechanistic conception does not imply that psychical can be explained by the physical; to it these t fields appear separate, though not unconnected" (p. This leads to brief discussions as to what is meant b "causal dependence," and as to how far it is possible to speak of an "explanation" of natural phenomena, after which the author passes on to review and criticise the objections raised by neo-vitalists to the possibility of explaining vital phenomena from a physicochemical standpoint.

It is not possible here to follow the author into the details of his arguments upon this abstruse theme for which we must refer the reader to the original Suffice it to say that the lecture makes interesting reading but by no means of a light order, since almost ever sentence requires to be pondered over before it can b assimilated, and we imagine that the inevitable butterfly element amongst the professor's audience must have found it difficult to gather honey from such very solid mental food. Perhaps the difference between the mechanists and the vitalists is nowhere brought out better than on p. 17. A neo-vitalist, Cossmann, having asserted that an artificially manufactured body, of the same materia and of the same structure as a plant, would neverthele not be an organism, Bütschli replies that "a bod built up in exactly the same way, both as regards stru ture and material, as a given plant, cannot, under suitab external conditions, behave otherwise than would the plant in question, *i.e.*, it would live like it." So long this ideal artificial organism has not been put togeth it seems a little difficult for an unbiassed critic (if the be any such) to assert confidently, either with t mechanist, that it would behave as a living body, or wit the vitalist, that it would be in the condition of a dea one. Incidentally, Bütschli declares his belief that t Darwinian theory of evolution, in spite of the many rece attacks upon it, remains the most probable of the vari attempts at explanation, and "contains the possib general solution of the problem," especially if combin with the hypothesis of germinal variations, which alo are capable of being inherited (pp. 33 and 89). In con clusion, the author claims that, in vital phenomena, "only that can be comprehended which can be physico-chemically explained." As regards the merits of the vitalistic and mechanistic points of view, he is content d clare, "By their fruits shall ye know them!"

E. A. M